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RECENT ADVANCES IN OBSTETRICS AND GYNÆCOLOGY

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BY

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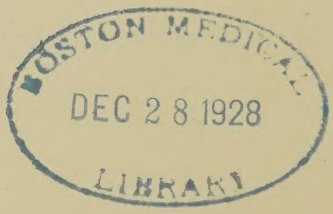

PREFACE

The rapid advance of all branches of Medicine renders it necessary to pause from time to time and take stock. But so technical is much of the new knowledge, and so widespread is its publication in almost all languages of civilisation that it is difficult for the fully-occupied practitioner to follow the results of new discoveries or the trend of present-day opinion. Further, it is not always easy to appraise the value of so-called "advances," to sift the wheat from the chaff. Some discoveries profoundly alter the trend of medical opinion both in theory and practice, while others, the greater part, after perhaps ephemeral popularity, fail to leave any permanent impression.

This book is an attempt to set forth briefly and concisely certain new matter in Obstetrics and Gynæcology. While sharing in all new knowledge of general Medicine, Surgery and Pathology, there are some lines of advance peculiar to this special subject which it seems worth while to record. An obvious difficulty which confronted me at the outset was the selection of matter which might legitimately be regarded as "Recent Advances." These words are relative terms, and, as such, may have variable interpretations, but the ideal aimed at has been to record only that new work which has been tested sufficiently to establish it as of real practical and permanent value. But while it is necessary to describe new work, it is perhaps even more important to record movements of thought, and trends of opinion. Opinions on former theories and teaching consolidate as time passes, and it is well to record the results of such experience. Perhaps the latter form of presentation of the subject may be of even more value than the description of actual new "discoveries." Not many new discoveries, or, shall we say, methods built upon them, wear well with passing time, and only by delay and extended trial can the real step forward be registered. Where, however, opinions have become crystallised after long experience, even though the basic facts are not actually new, I have set them forth. An example is the chapter on

Ante-natal Care. There are no new facts recorded in this chapter which have not been known for some years, but experience of the practice of Ante-Natal care has proved the system to be of so much practical value that the omission to include an account of it in a work of this kind would distort the whole presentation of the section of Obstetrics. As it is the most important single line of forward movement of thought in Midwifery during the last ten years, even though the knowledge is not recent, it is emphatically necessary to describe it.

The confines of Obstetrics itself have not been greatly extended by new scientific or laboratory work, with the exception of many attempts to solve the chemical problem of metabolism in pregnancy. A very great deal of work has been done on these lines which has resulted in the establishment of many isolated chemical facts, but sufficient co-ordination has scarcely yet been accomplished for practical clinical work to be greatly influenced.

The outlook in Obstetrics has, however, been widened during recent years by certain clinical investigations, such as those carried out in maternity and fœtal mortality, and the treatment of Eclampsia. Though labouring under obvious disadvantages, such methods of clinical research do yield results which are of practical value.

In the section of Gynæcology I have been fortunate in securing the collaboration of special workers in dealing with three highly technical methods of diagnosis and treatment. Dr. Douglas Webster has very kindly contributed the account of the use of X-rays in Obstetrics and Gynæcology, while Dr. Justina Wilson has written the chapter dealing with the applications of Electro-Therapeutics to Gynæcology, and Dr. Malcolm Donaldson, whose large experience of radium in the treatment of carcinoma of the cervix is a special qualification, has dealt with this promising new field.

My thanks are also due to the numerous writers whose works I have freely consulted, and particularly to Drs. Holland, Fothergill and Bailey, for the use of various illustrations.

In conclusion, I should like to express my thanks to the Publishers for their unfailing courtesy and assistance.

A. W. B

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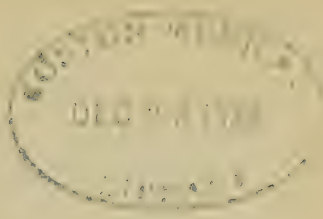

RECENT ADVANCES IN OBSTETRICS

PART I. OBSTETRICS

CHAPTER I

ANTE-NATAL CARE

It is only of recent years that obstetrics has been recognised as a branch of preventive medicine, but there is now so great an amount of attention devoted to this aspect of midwifery that it takes a large place in any wide scheme of preventive medicine. This attitude towards obstetrics, first of the profession and now of the public, is thoroughly justified in view of the immense amount of ill-health and disability which can be prevented by ante-natal supervision and the proper conduct of labour. Many a woman dates a life-long invalidism from a confinement, usually the first, due to difficulties which could easily have been recognised and as readily prevented. When it is remembered what an important, nay essential, social unit is the working mother in our economic system, too much stress and emphasis cannot be laid upon the necessity of preventing incapacity for her domestic and maternal duties by a prolonged and even permanent impairment of her health.

It is the chief part of the office of obstetrics to ensure that when a woman has a child she should emerge from the ordeal in as good a state of health as before pregnancy began, not incapacitated for her new responsibilities by an acquired

physical weakness, but fit and able to carry out the vitally important duties of motherhood. A consideration of the various difficulties and disasters of labour shows us forcibly how largely they are capable of prevention by recognition and treatment beforehand, and it is this characteristic feature of obstetric emergencies which renders ante-natal supervision so promising a field of preventive medicine.

The inclusion of a chapter on ante-natal diagnosis and care in a book of this nature is therefore justified, not so much because of any radically new methods of procedure, but rather because of the recent wide adoption of ante-natal examination throughout the country, and also because its universal extension to all pregnant women is urgently necessary.

The objects of ante-natal examination may be set forth as follows :—

1. General examination.
2. Determination of presentation.
3. Measurement of pelvis and estimation of possible disproportion between head and pelvis.
4. Urine examination.
5. Examination for presence of vaginal discharge or venereal disease.

1. The general examination of the patient is necessary for every primigravida or other patient seen for the first time. It is particularly necessary to examine the heart and lungs and search for possible septic foci. In view of the probability of autogenous foci being frequent causes of puerperal fever, the detection and treatment of a septic focus during pregnancy are important elements in prophylaxis. The teeth are frequently the seat of sepsis either in the form of cavities and apical abscesses or pyorrhœa. The well-known tendency of caries to progress during pregnancy is an additional reason why the mouth should be put into good order as early in pregnancy as possible. Recent or repeated " sore throats " may mean a virulent organism in the tonsils or pharynx,

which may be a source of danger after delivery. Adequate medical treatment should be adopted as early as possible. Varicose veins and other minor troubles should be noted and treated if necessary.

2. The accurate determination of the presentation is necessary during the last four weeks of pregnancy. Before this time a change of fœtal lie is so frequent that the presentation may be largely disregarded. It has been shown, for example, that about 60% of all breech presentations at the 30th week become spontaneously converted to the vertex lie during the interval 34–36 weeks (McIlroy), while an even greater proportion of occipito-posterior presentations undergo spontaneous rotation to the anterior position before labour.

Should great variability of presentation be noted at different ante-natal examinations, it is prudent to suspect the existence of an abnormality which prevents the head engaging in the brim, such as a contracted pelvis, placenta prævia or twins. If, on the other hand, the first vertex position is found consistently present with the head engaged and well flexed, it is highly improbable that spontaneous alteration will occur.

Frequently the child is found lying with the back to the mother's side, *i.e.*, mid-way between the anterior and posterior positions, especially about the 36th week. This, the left or right occipito-lateral position, persists if the pelvis is flat, up to and during the first stage of labour, but if the pelvis is normal, spontaneous rotation will take place into the occipito-anterior or posterior lie. Which of these two will happen it is not possible to say, except that the forward rotation is much the commoner, especially if the head is flexed. The condition of the head, *quâ* flexion, is the chief guide to the ultimate position taken up. A previous knowledge of the presentation before labour begins is immensely important. For example, if a breech is detected at 36 weeks external version should be attempted. Before 36 weeks it is unnecessary as version is likely to be spontaneous,

after the 38th week it is usually difficult owing to the greater immobility of the child. It is only possible to succeed in this manipulation in about half the cases attempted, but it is always well worth while to try the manœuvre inasmuch as spontaneous version will usually follow attempts to turn by hand, probably because of the disturbance offered to the fœtus. Some occipito-posterior positions can be corrected before labour by the application of a padded binder. The pad is presumed to press down upon the child's back and thus induce it to rotate to the front. As the binder does no harm, it may be applied during the last few days of pregnancy. Determination of the lie of the child will also include an estimation of what degree of flexion of the head exists. Roughly, the completeness of the flexion is measured by the prominence and height of the forehead above the occiput. Where the head is well flexed it can be assumed that the back will be anterior and that the normal mechanism of labour will progress easily. Further, if good flexion exists with a slight degree of pelvic contraction, it is probable that the degree of disproportion will be small and overcome without difficulty. If, however, the head is badly flexed, as shown by the equal prominence of forehead and occiput, there may be an occipito-posterior position or a delay in the normal mechanism which will mean prolongation of labour.

3. **Examination for Disproportion between the Fœtal Head and the Pelvis.**—Perhaps the most important single object of the ante-natal examination is the detection of disproportion between the head and the pelvis. By measurement of the pelvis, pressing the head into the brim, and vaginal examination of the pelvic cavity it is possible to detect almost every case in which mechanical difficulty will occur.

(*a*) *Measurement of the Pelvis.*—The diameters of the normal pelvis have the following measurements :—

Inter-spinous diameter . .	9–10 in. (22·5–25 cm.).
Inter-cristal diameter . .	10–11 in. (25–27·5 cm.).

External conjugate diameter . $7\frac{1}{2}$ in. (18·75 cm.).
Posterior Inter-spinous diameter . . . . $4–4\frac{1}{2}$ in. (10–11·25 cm.)

Every primipara should be measured, and all multiparæ attended for the first time. It is important, however, to recognise exactly how far pelvic measurements may be of practical use. Firstly, it is true that no prognosis can be founded on measurements unless sufficient experience has firstly been obtained of the normal pelvis to form a standard for each particular observer. Each observer will develop his own standard of the normal measurements owing to the personal factor which must enter into measurement of points so inexact as blunt bony landmarks covered with skin and fat. Having obtained his own standard of the normal pelvis he will then be in a position to compare measurements of any patient and estimate therefrom what real pelvic contraction any deviation may mean.

Further, it is necessary to know how far each particular diameter is of value as an index of the normal. For example, the anterior inter-spinous is extremely variable in the normal pelvis, and as it has no relation to the true pelvis it is only gross degrees of diminution which indicate contraction, while, on the other hand, the external conjugate is remarkably constant, and comparatively small deviations here may indicate a pelvis small enough to cause difficult labour.

The *anterior inter-spinous diameter* varies in the normal pelvis between 8 and $10\frac{1}{2}$ in. Only marked contraction should be regarded as important, and then only *when taken in conjunction with the other measurements.* In the rare rickety pelvis it may be increased.

Inter-cristal Diameter.—Taken between the widest part of the crests of the ilium, it is more useful than the inter-spinous as a measure of generally contracted pelvis. Below 10 in. (25 cm.) it usually means some degree of general contraction. It is roughly a measure of the transverse diameter of the brim of which it is twice the length.

External Conjugate.—This must be taken as accurately as possible between the 5th lumbar spine and the upper border of the symphysis pubis. Normally $7\frac{1}{2}$ in. (18·75 cm.), a diminution of $\frac{1}{2}$ in. (1·25 cm.) may, taken with other measurements, indicate a definite degree of contraction. A distance of $6\frac{1}{2}$ in. (16·25 cm.) is almost surely a sign of flat pelvis.

The *posterior inter-spinous diameter* is valuable inasmuch as it is roughly a measure of the width of the sacrum at the level of the brim, and therefore an indication of general contraction of the pelvis. It is unaltered in the simple flat pelvis, because this deformity is an approximation of a normally wide sacrum to the symphysis pubis. It should measure from 4–$4\frac{1}{2}$ in. (5–6·25 cm.), but it is only possible to obtain an accurate measurement in thin women.

The diameters of the *outlet* are very difficult to measure accurately on account of the amount of fat covering the ischial tuberosities, and the indefinite position of the tip of the sacrum. The tip of the coccyx is a movable point during the expulsion of the head, and therefore a measurement taken from this point is likely to be less than the available space produced by the bending backwards of the coccyx.

Fortunately it is only very rarely that the outlet is contracted. The commonest condition is the generally contracted pelvis ; but here, if the head has already been able to pass down through the brim and pelvic canal, it will be able probably to pass through the outlet without greater difficulty. It is only in the rare funnel-shaped and kyphotic pelvis that the outlet appears to be clinically contracted, *i.e.*, to present great difficulty for the birth of the head after it has already descended so far with comparative ease.

The simplest clinical method of estimating the size of the outlet in a suspected case of contraction is :—

(*a*) Note the width of the pubic angle by the finger pressed in front against the pubic arch on each side of the urethra. There should be a recess here large enough to accommodate the index finger.

(*b*) Attempt to press the three knuckles of the first inter-phalangeal joints transversely between the ischial rami, *i.e.*, at a point immediately behind the vaginal outlet. This space should easily accommodate three knuckles, and possibly four.

Deductions to be Drawn from Pelvic Measurements.—The measurements of the pelvis will give us information : (*a*) of the absolute size ; (*b*) of the shape of the pelvis.

(*a*) It is necessary to survey the figures as a whole, paying chief attention to the external conjugate and the posterior inter-spinous diameters. Comparatively small contractions here should raise suspicions of a reduced pelvic capacity and special care should be devoted to confirming the existence of contraction by manipulating the fœtal head into the brim.

The inter-cristal diameter is not of much significance unless it measures under 10 in. (25 cm.), while variations of the anterior inter-spinous are of little moment unless the other diameters are also reduced. If all the measurements are normal or increased, and the finger in the vagina cannot feel the promontory or the posterior half of the brim, it may be concluded that the pelvic cavity is of normal size.

(*b*) The shape of the pelvis, if contracted, is of great importance for the purpose of prognosis of the forthcoming labour. While the slighter degrees of flattening will not as a rule offer much mechanical difficulty, great care must be exercised in dealing with generally contracted pelvis by suitable induction of premature labour, or, if necessary, Cæsarean section.

Pelvic measurements will assist in the diagnosis of the shape as follows :—

Simple Flat Pelvis.—(*a*) The inter-spinous and inter-cristal diameter yield no information. Only in the severe forms of flattening due to rickets will the two diameters tend to approximate or equal each other in length.

(*b*) The external conjugate is definitely reduced. If the reduction is from $7\frac{1}{2}$ in. (18·75 cm.) to $6\frac{3}{4}$ or $6\frac{1}{2}$ in. (17 or 16·75 cm.) some degree of flattening is probable.

(*c*) The posterior inter-spinous diameter is unaltered.

(*d*) The outlet is normal.

(*e*) The sacral promontory can be felt.

Generally Contracted Pelvis.—(*a*) All the measurements are reduced.

(*b*) No one diameter, except possibly the anterior inter-spinous, is greatly reduced.

(*c*) The external conjugate is usually about 7 in. (17·5 cm.).

(*d*) The posterior inter-spinous diameter is characteristically reduced to $3\frac{1}{2}$ in. (8·75 cm.).

(*e*) The outlet gives the impression of being less roomy than normal.

(*f*) The sacral promontory cannot be felt.

The Relation of the Fœtal Head to the Brim.—However carefully the pelvic diameters may be measured, we have still an unmeasureable factor in the child's head, and the existence of disproportion with possible difficulty in labour can only be finally confirmed by noting the relation of the child's head to the brim.

Three degrees of relation may be observed :—

1. The head may be *engaged.* This is easily determined by finding the head sunk into the brim and *fixed, i.e.*, incapable of being moved laterally from side to side. If the head is engaged and fixed, disproportion does not exist.

2. The head may be *engaging.* It is only partially above the brim, the largest diameter has not engaged, and it can be moved laterally from side to side about an inch, further movement being prevented by the lateral brim.

If the head is *engaging*, it is probable that it can be pushed well down into the brim by firm continued pressure, whereby the movable head will have become converted into a fixed head.

Under such circumstances there is no disproportion.

3. The head may be "*floating*," *i.e.*, wholly above the brim, and freely movable from side to side.

An attempt should first be made to fix it over the brim by

pressure by an assistant on the fundus. The head is then steadily and very firmly pressed down and backwards by both hands.

It will now be found :—

(*a*) That it can be pressed down quite easily into and through the brim.

(*b*) That it can only be pressed down *into* the brim, but not *through* it, and this only with difficulty.

(*c*) That no amount of pressure will convert the floating head into an engaging head, *i.e.*, that all of the head still remains above the brim.

It may further be noticed that *overlapping* of the head over the symphysis pubis is present, and of this there are clinically two degrees :—

(*a*) The head overlaps the whole thickness of the symphysis and overhangs its anterior surface.

(*b*) The overlapping is only partial, *i.e.*, the head only overlaps the deep border of the upper margin of the symphysis, but cannot be felt overhanging its superficial aspect. The extent of overlapping is therefore not greater than the thickness of the symphysis.

On consideration of this clinical examination, we find that when the head can be pushed into and through the brim there will be no mechanical difficulty. If the head can only be pushed into the brim with difficulty the probability is that labour, induced at that time, will terminate naturally. But if the head cannot be pushed into the brim at all, then the probability is that there will be serious trouble, perhaps requiring prolonged forceps delivery or craniotomy.

As regards overlapping of the symphysis, if the head overhangs the anterior border of the symphysis it can scarcely be moulded through and survive, while if it only overlaps the deep border but not the superficial, it is possible for successful moulding to occur, without injury.

In addition to noting the ease or difficulty of pressing the head down it is necessary to take into account the degree of

flexion or extension of the head. For example, a badly-flexed head which can only be pressed in the brim with difficulty may pass through without trouble as soon as flexion becomes complete, while if the fully-flexed head cannot be pressed in and down, it is probable that a condition of true disproportion exists.

4. **Examination of the Urine.**—The routine testing of the urine for albuminuria has very greatly diminished the incidence of eclampsia by enabling timely prophylactic treatment to be carried out. It is necessary to treat the urine for albumin after the middle of pregnancy once every fortnight, and during the last month it should be done every week. It is possible for eclampsia to supervene after only a very short stage of albuminuria, and, therefore, it is not enough to rely upon a test every fortnight during the last month.

If a catheter is not used the patient should be instructed to sponge the vulva down before micturition and to pass water in two portions, rejecting the first portion. If a trace of albumin is found, its presence should be confirmed by testing a catheter specimen.

If albumin is present in a catheter specimen, it should further be examined for pus by the microscope, in order to eliminate the possibility of pyelitis or cystitis.

Glycosuria is not uncommon during pregnancy, and sugar should therefore be tested for at least once during the latter half of gestation. If the patient is quite well and the blood sugar is normal (see p. 73), the glycosuria of pregnancy can be neglected.

5. **Venereal Disease.**—Venereal disease will be suspected firstly by a history of miscarriages or premature still-births, secondly by the presence of a free purulent discharge on vaginal examination. If syphilis be suspected by the history or any other details revealed by the patient or her husband, a Wassermann reaction of both husband and wife should be done at once.

The chances of the birth of an uninfected baby are very good if the patient is treated before the last two months; indeed, it can be said that it is never too late to institute treatment. One of the most striking successes of the treatment of syphilis is that of the fœtus *in utero* by treatment of the pregnant woman.

The presence of a purulent discharge should always excite a suspicion of gonorrhœa, especially if there is vulvitis present or pus in the urethra.

During pregnancy the clinical signs of gonorrhœa usually become accentuated, while if contracted during pregnancy the infection is liable to be very severe.

Bacteriological confirmation should be sought by examination of smear preparations from the cervical canal and urethra, repeated two or three times if necessary. In any case a purulent discharge must be treated during pregnancy, as it is a formidable source of infection of the uterus after labour and also of the child's eyes.

Swabbing of the cervical canal, urethral bougies of protargol, collosal argentum pessaries and a douche will do much to eliminate the infection.

CHAPTER II

A REVIEW OF MATERNAL MORTALITY

THE recent publication of the Report on Maternal Mortality by Dr. Janet Campbell for the Ministry of Health (1924) has focussed attention still more strongly on the risk to life which attends childbirth. It has shown how the mortality in England and Wales is not only absolutely high, but it is relatively high when compared with the rate of many other European countries. The analysis of the causes of death serves to show that the majority of fatal cases should be under the control of preventive methods, and is a striking brief for the urgent need for ante-natal care. It must be remembered also that for every woman who actually loses her life in labour there are very many whose health is permanently impaired by the effects of a difficult labour.

The crux of the problem may be stated briefly in figures. There are over 700,000 births every year in England and Wales, and of these mothers approximately 3,000 have died each year during the last ten years. These are deaths occurring in the prime of life, in the exercise of what should be a natural function, and involve the homes of the people in a vast amount of economic loss and grief. It is unnecessary to stress the only too obvious points that the loss of the mother of a new-born baby and other young children is not only serious, to her family, but, by the deprivation of maternal care and training, is a source of imperfect citizenship to the State.

Deaths in labour are, therefore, amongst the most economically serious, and, with improved midwifery service, largely preventable.

There are four methods by which this end can be obtained :

(*a*) Improved obstetric training of medical students and post-graduates.

(*b*) Improved training of the midwife, and raising of her status and pay.

(*c*) Education of the public to expect efficient care before the confinement.

(*e*) The universal adoption of ante-natal examination.

It is with the last of these that we are specially concerned here, but before dealing with its clinical details, it may be well to set forth certain items from Dr. Campbell's Report which will serve as exact and tangible evidence of the great need for the care of pregnancy.

Maternal Mortality in England and Wales

Taking the group of married women during the reproductive age (fifteen to forty-five) there were in 1913, 22,256 deaths of which 3,456 were due to some accident or disease of child-bearing, or a mortality rate which was the third largest of all causes of deaths of this age group. The female death rate from all causes has declined very considerably during the last fifty years, but this is in striking contrast to the mortality from childbirth alone which has declined relatively very little. The same observation applies to the infant death rate, which has declined from 156 per 1,000 in 1896–1900, to 77 per 1,000 in 1922. As Sir George Newman points out in his Introduction to Dr. Campbell's Report, "the childbearing mother is not sharing equally with the rest of the population in the improved public health."

The actual figures of mortality, distinguishing deaths due to sepsis from other causes, are shown in the table given on p. 14 :—

It will be noted from these figures that :—

1. The general mortality has not declined since 1906–1910.
2. The deaths from sepsis amount to a relatively large

proportion of the total deaths, *i.e.*, in many years more than half.

3. The mortality due to sepsis has remained stationary for the last ten years.

Year.	Deaths for 1,000 Births.			Infant mortality rate.
	Sepsis.	Other causes.	Total childbirth.	
1891–95	2·60	2·89	5·49	151
1896–1900	2·12	2·57	4·69	156
1901–05	1·95	2·32	4·27	138
1906–10	1·56	2·18	3·74	117
1911–15	1·50	2·31	3·81	110
1916–20	1·59	2·29	3·88	90
1910	1·42	2·14	3·56	105
1911	1·52	2·15	3·67	130
1912	1·47	2·31	3·78	95
1913	1·34	2·37	3·71	108
1914	1·63	2·32	3·95	105
1915	1·56	2·38	3·94	110
1916	1·47	2·40	3·87	91
1917	1·39	2·27	3·66	96
1918	1·35	2·20	3·55	97
1919	1·76	2·36	4·12	89
1920	1·87	2·25	4·12	80
1921	1·46	2·25	3·71	83
1922	1·38	2·43	3·81	77

4. The deaths due to other causes show a tendency to increase.

5. There is a striking reduction in the infant mortality rate.

When compared with other European countries, the position of England and Wales is not such as to give satisfaction. Though the methods of registration vary slightly in other countries, the broad results of the comparison are trustworthy.

RATES OF MATERNAL MORTALITY PER 1,000 LIVE BIRTHS FOR THE YEARS 1911–1913

Scotland. . .	5·70	Germany . .	3·48
Spain . . .	5·27	Norway . .	2·90
Switzerland . .	5·21	Italy . . .	2·44
France . . .	4·78	Sweden . . .	2·42
England and Wales .	3·94	Holland. . .	2·29

The excessive rates of Scotland and Switzerland, as also of some English and Welsh counties, are accounted for by the mountainous nature of the terrain and the consequent difficulty of access in times of emergency. The comparatively low figures of Norway and Sweden are, however, exceptions to this inference.

The distribution of mortality in this country on the basis of rural or industrial areas is instructive. The chief observations arising out of a mass of minute analysis are :—

1. Mortality from all causes is highest in rural (particularly mountainous) areas, but there is relatively less puerperal fever in these districts than disasters from other accidents of labour. This might be expected on account of the less likelihood of interference in labour, which would operate both in reducing the amount of sepsis, and also, in the other category, in failing to render timely aid in cases of mechanical difficulty.

The rates of mortality for rural areas (1921) are as follows :

	England.	Wales.	England and Wales.
Sepsis . .	1·24	1·8	1·25
Other causes .	2·83	4·55	2·97
All causes .	4·07	6·35	4·22

2. Mortality in industrial areas varies very considerably. For example, certain county boroughs in the textile and

mining areas show very high rates, such as (1919–22)—Halifax 7·82, Rochdale 7·05, Swansea 6·59, while in others, such as West Ham, the rate was only 2·03 for the same period, which was the lowest of any county borough. In Shoreditch the rate was only 2·55. These are essentially working-class areas, and, curiously enough, returned a lower rate than Hampstead, which is a typically residential district.

3. The mortality of the London area is the lowest of any, and is returned as follows (1921) :—

Sepsis	1·42
Other causes	1·56
All causes	2·98

The highly congested state of London might be expected to provide a higher risk than less populous districts, but this possible factor is probably more than counteracted by the efficient transport of the city, the larger number of doctors and midwives, and the greater amount of institutional facilities than are found in most other towns or any rural area.

The variations in mortality in the areas described above are not special to any one year, but the differences remain constant over a number of years, suggesting that some constant factors are at work in all parts tending to maintain the same results.

General Causes of Maternal Mortality

In another part of this book we shall examine the clinical aspects of the causes of puerperal sepsis in detail in the light of the Report on Puerperal Sepsis published by the Committee of the Obstetrical and Gynæcological Section of the Royal Society of Medicine, but as certain general conditions can be identified as influencing the total mortality, we shall consider Dr. Campbell's deductions under this heading.

1. **The Available Professional Attendance.**—The number of women attended by doctors or midwives varies considerably in different districts. In 1922, 50% of the

total births were notified by midwives, but in Wolverhampton 81·7% of the labours were conducted by midwives, while in Newcastle the rate was only 28·6%. The mortality of these towns was, however, almost identical, standing at 4·7 and 4·8 respectively. It is impossible to draw any accurate conclusions from these figures, except that the mortality seems to be unaffected in these two towns, but it is well known that there is a smaller death rate amongst midwives' cases, easily accounted for by the fact that midwives attend chiefly normal cases, while doctors are called in to deal with emergencies.

While it is very probable that the obstetric skill of the British practitioner is as high, if not higher, than that of any other, and also that the general level of obstetric skill in this country is satisfactory, this cannot be laid to the credit of the doctor's training in midwifery while a student in our medical schools. The really high degree of skill possessed by most practitioners has very largely been gained by their post-graduate experience founded on a very sound training in the basic principles of anatomy, medicine and surgery. But, while the writer is unable to agree with Dr. Janet Campbell in her general depreciation of the midwifery service, he does feel that in exceptional cases the standard of skill, care, and knowledge is very low, and that this professional failure, exceptional though it may be, is responsible for a considerable amount of preventable mortality. Anybody on the staff of a large maternity hospital cannot but hold this view in the light of his hospital experience. The solution of this problem lies in the medical schools, and while we can proudly point to many advances in obstetrics, we are unable to include the teaching of midwifery as an example of these advances. Only very slowly is improvement being made. The bed accommodation in general hospitals is still very inadequate for teaching purposes, and the time devoted to this branch of medicine is still too short. As a subject of instruction, midwifery should rank equally with medicine and surgery,

and the student should be led to regard it as equally important. Knowing very well the unsatisfactory and incomplete education of the student, the writer has a high regard for the level of knowledge and skill he achieves after engaging in practice.

2. **Rickets.**—Rickets is a factor in the production of maternal mortality in so far as it causes pelvic contraction and therefore difficult labour. But the true rachitic pelvis is rare in London, and in south and rural England and Wales, and it is seldom that a difficult forceps delivery can be indirectly attributable to rickets.

The effect of employment on women may be indirect in so far as it results in feeble development and stunted growth of the adolescent girl, or direct if the actual work done be of an exhausting nature, particularly during the latter weeks.

So much care is taken with regard to the health of factory workers that the direct effects of employment are comparatively unimportant.

The influence of general cleanliness and sanitation is of considerable importance, though perhaps not as great as might at first be expected. It is common knowledge that patients delivered in squalid slum dwellings make uninterrupted recoveries from labour in the vast majority of cases. Bad housing, however, at once assumes enormous importance in midwifery if manipulative delivery has to be undertaken. It is quite true that the normal unexamined patient will do as well in a hovel as in a hospital, but the least form of intra-vaginal examination or interference immediately involves the woman in a much greater risk. For this reason, amongst others, is institutional conduct of midwifery of so great value for the poorer classes.

Clinical Causes of Maternal Mortality

While it is possible to state the number of deaths due to accidents and diseases of pregnancy and childbirth, it is obviously impossible to convey any impression of the large

amount of disability and impaired health and efficiency directly resulting from a confinement. The writer analysed the patients attending his clinic at the Samaritan Hospital for Women over a period of many years, and found that no less than one-third of all the patients complained of lesions directly attributable to labour or abortion. This is a very high incidence of disease, and serves to emphasise still further the necessity for ante-natal care. The number of deaths occurring in 1922 resulting from pregnancy and childbirth are given by Dr. Campbell in her Report as follows :—

Cause of Death.	Number of Death
Abortion	92
Ectopic gestation	86
Other accidents of pregnancy	132
Toxæmia	556
Hæmorrhage in pregnancy or labour	390
Other accidents of childbirth	304
Puerperal sepsis	1,079
Embolism and sudden death	242
Phlegmasia alba dolens (not returned as septic)	54
Puerperal insanity	30
Puerperal disease of the breast	6
TOTAL	2,971

The important problem of puerperal sepsis will be dealt with in another part of this book, but it is well here again to draw attention to the preponderating influence of puerperal fevers in the above table, and to point out that the greatest improvement in the mortality rate of childbirth will be achieved by the prevention of this condition.

As I hope to show later, the chief indirect causes of puerperal sepsis are difficulties in labour requiring manipulative delivery with or without extensive damage to the soft

parts, and it is precisely this kind of difficulty which can be prevented in a very large number of cases by treatment based upon ante-natal examination and diagnosis.

PREGNANCY TOXÆMIA

After sepsis the various forms of toxæmia accounted for the next highest number of deaths, and here again we have in ante-natal recognition of albuminuria an obvious warning of the impending danger in all but a very small minority. Dr. Campbell states in her Report that "the impression is gained from the fatal cases especially investigated that there was usually no ante-natal care, often because the patient failed to seek advice for obvious symptoms, and that even when given the supervision and treatment were apt to be incomplete and ineffective." This statement is amply borne out by hospital experience. Nearly every case of eclampsia admitted to Queen Charlotte's Hospital has either not had the urine tested, or possibly only once some weeks or months before. It is very rare for a patient who has been under the care of the hospital ante-natal clinic to develop eclampsia, because every patient is seen at frequent intervals when the urine is tested as a routine part of the examination. If any albumin is detected the woman is admitted to hospital and treated by suitable medical measures or induction of labour if there is evidence that the toxæmic process is not yielding.

It is possibly true that a very small fraction of cases of eclampsia have not been preceded by albuminuria, or for so short a time that there was no opportunity for examination of the urine, but such cases are very few.

The presence of long-continued albuminuria, and therefore of impaired or strained renal function, is of further importance in so far as it may, and almost certainly does, lead to some permanent impairment of the kidney. In this way future health will suffer, another pregnancy will be of greater danger, and life may ultimately be shortened by chronic

nephritis, the seeds of which were sown in a neglected albuminuria of pregnancy.

In considering toxæmia of pregnancy it is well to mention that, while albuminuria is the commonest prodromal symptom, there is another type of very severe and usually fatal toxæmia of hepatic origin whose initial symptom is uncontrollable vomiting in late pregnancy. Albuminuria is absent during the early stages, and therefore it may be thought that vomiting is of no great importance ; but it should be remembered that severe vomiting coming on in late pregnancy may be the prodromal symptom of acute yellow atrophy, and must be regarded even more seriously than albuminuria as justification for early or even immediate induction of labour.

It is a fair estimate, therefore, to state that, under efficient ante-natal supervision and treatment, as many as four-fifths of the 556 deaths from toxæmia in 1922 might have been saved.

DIFFICULT LABOUR

The direct causes of death in difficult labour are shock, hæmorrhage and sepsis, and of these the last is by far the most important. It is perhaps in the prevention of mechanical difficulties in labour that ante-natal care has its chief justification. The correction of breech and transverse positions, timely induction of labour or possibly Cæsarean section for pelvic contraction will all tend to abolish those obstetrical disasters which end in grave damage to the mother and destruction of the child.

HÆMORRHAGE IN LABOUR

Of the total of 2,971 deaths in 1922, 390 cases were due to some form of hæmorrhage in late pregnancy or labour. Ante-partum hæmorrhage cannot be prevented by ante-natal care, but by prompt treatment when it occurs, much may be done to diminish its mortality. Successful treatment

depends more on the skilful conduct of labour than on anything that can be done by way of prophylaxis. The same remark applies to post-partum hæmorrhage, which can be foreseen even less than ante-partum hæmorrhage. Here again a wise management of labour will have the greatest effect both in preventing bleeding after delivery and arresting it when it occurs.

The Prevention of Maternal Mortality

The complexity of the problem is so great that no single method can possibly make much impression on mortality. So many factors enter into the whole process of childbirth and attendance thereon that it is only by examination of all those operating adversely, and by evolution of measures capable of dealing with each difficulty, that improvement can be effected. It is therefore impossible to attack the problem successfully from any one point of view or by any one group of workers acting alone. For example, though greater professional knowledge and skill on the part of obstetric practitioners may achieve considerable results, or increased efficiency of the local government authority lead to improvement, their individual efforts must be limited short of the utmost possible success, and it is only by co-ordination of all forces that the best results can be obtained. No amount of professionals kill is of use to a woman in difficult labour if geographical conditions and transport arrangements are such that the two cannot be brought together, while if the local authority, hampered either by lack of funds or foresight, is unable to provide the assistance required by necessitous cases, no amount of conscientious notification will result in any benefit to the puerperal patient. Lastly, it is obvious that the most efficient midwifery service obtainable will be deprived of its maximum usefulness if the public remains uninstructed on the importance of the hygiene of pregnancy or the proper

management of labour. The co-operation of all parties concerned is necessary to secure results commensurate with the great need.

While it is outside the scope of this book to consider in detail where improvements are required, it may be profitable to set forth briefly the suggestions made by Dr. Campbell in her Report, to which the reader is referred for a full account of her recommendations.

IMPROVEMENTS IN TRAINING

It is true that perhaps the most important of the advances in obstetrics would be the improvement in the education of the medical student and the pupil midwife. In all the medical schools great efforts have been made, particularly within the last ten years, to provide a better instruction in midwifery. There is now more direct clinical teaching in place of the formal lecture, and more direct supervision of the student during his early experience of the conduct of labour. This has largely resulted from the gradual establishment of maternity beds in the teaching hospitals, and the more general practice of attendance at the clinics of the lying-in hospitals. But, though improvement has taken place along these lines, it has only just begun, and still has far to go before it can be said that instruction in midwifery is equal to that given in medicine and surgery. There is still relatively too much time of the clinical curriculum devoted to these branches compared with that devoted to so highly important a department of general practice as obstetrics. Most students will never have to perform a major surgical operation, but nearly all taking up general practice may be called upon to deal with difficult labour, and *all* should be fully equipped to *prevent* the occurrence of difficult labour as far as ante-natal supervision can do this.

Similar improvement has been made in the training of the pupil midwife both in time of probation and quality of

teaching. In the training of the midwife too much stress cannot be laid upon : (1) ante-natal care ; (2) clean management of normal labour ; (3) quick recognition of abnormalities in labour ; (4) puerperal nursing.

While considerable progress has been made in the " pre-certificate " training of midwives, there is still room for more organised " post-certificate " teaching, especially for those nurses who practise in isolated rural areas. The ideal to aim at is a systematic but brief " refresher " course at some neighbouring centre held once a year and presided over by one who has devoted time and care to render himself specially proficient in the teaching and practice of obstetrics.

A further means of improvement of the midwifery service generally would result from a closer co-operation between doctor and midwife. While it is true that the vast number of labours can be properly attended by midwives, it is certain that much difficulty in labour might be prevented if every case of late pregnancy (36th week) was seen once by a doctor. If midwives and doctors could co-operate in this manner and persuade the pregnant woman that she should be examined at least once by a doctor at the critical time (36th week) there would be a greater chance of the elimination of possible difficulties and dangers in the forthcoming labour. While not unduly taxing a doctor's time, this system would involve a greater control of midwifery being in the hands of qualified practitioners, and it would not mean all the waste of his time caused by unnecessary attendance at a large number of normal confinements.

Assistance by the Local Authority.—Up and down the country the local authorities, under the ægis of the Ministry of Health, are taking a practical interest in the improvement of the maternity service. Establishment of ante-natal centres (of which about 560 already exist), staffed by practitioners who have had special training in ante-natal work, is one of the most valuable means both of educating the public and preventing obstetric difficulties and disasters. It is

hardly necessary to stress the necessity of the staff of these clinics being experienced in ante-natal work, and local authorities would be well advised in insisting on candidates for these offices having had instruction in recognised institutions.

The provision of maternity beds by all concerned is also an urgent necessity. General hospitals, cottage hospitals, and local authorities should regard the maternity side of their institutions as no less important than the medical and surgical. Accommodation is required not only for the conduct of expected difficult labours, but also for primigravidæ in necessitous circumstances, emergencies of labour, ante-natal treatment, and particularly for septic puerperal patients.

Lastly, it is obvious to ensure the harmonious co-operation of doctor, midwife, ante-natal centre, and institution that full details of any case seen in either of the two latter should be furnished to the patient's professional attendant.

CHAPTER III

THE CAUSATION OF FŒTAL DEATH

The awakening of public interest during recent years in some of the larger problems of obstetrics has resulted in careful inquiry into the important question of still-birth. It is obvious that we are dealing here with a problem of great social and economic consequence. Not only is a vast amount of potential child life sacrificed every year, but indirectly the saving of fœtal life by improved obstetrical methods would react upon the health of the mother by saving her from the difficult and damaging labour which has resulted in the death of her child.

While great progress has been made in the improvement of infant mortality during the last twenty years (from 156 per 1,000 in 1896–1900 to 77 in 1922), this reduction has not been noticeable in the case of infants during the first month of life, and it is probable that a larger part of the mortality of very young infants results from the injuries and diseases contracted either before or during birth. Not only, therefore, would improved obstetrical practice reduce the amount of still-birth, but it would also have its repercussion in the general infant mortality rate by saving many of the deaths during the first month of life. A recent survey of the causation of fœtal death has been made by Holland and others who collaborated with him, and in their report on the "Causation of Fœtal Death" (1), published by the Ministry of Health, many interesting facts have been established and deductions drawn. The report concerns itself with the post-mortem examination of 300 fœtuses, some fresh, others macerated, obtained from many different hospitals and

districts of London. It is, therefore, probable that the observations made by the examination of this representative group of 300 are a fairly accurate reflex of the actual conditions present throughout London or other large urban districts.

A. Maternal States

Disease.	Macerated.	Fresh.
Syphilis	39	3
Probable syphilis	5	1
Albuminuria of pregnancy	14	7
Eclampsia	1	4
Accidental hæmorrhage	11	20
Chronic renal disease	4	—
Other maternal diseases	3	1
Total	77	36

B. Complications of Labour

Complication.	Macerated.	Fresh.
Placenta prævia	4	32
Contracted pelvis	—	24
Breech presentation	—	16
Transverse presentation	2	8
Primary prolapse of cord	—	10
Coiling of cord round fœtus	1	1
Prolonged labour in vertex presentation	—	8
Brow presentation	—	3
Face presentation	—	1
Normal labour (excessive cranial stress)	—	9
Total	7	112

C. Placental States

Complication.	Macerated.	Fresh.
Retro-placental hæmatoma	5	—
Intra-placental hæmorrhage	1	—
Excessive infarction	—	2
Abnormally small placenta	10	—
Total	16	2

D. Fœtal States

Complication.	Macerated.	Fresh.
Deformities	2	8
Post-maturity	1	1
Absence of hypogastric artery	3	—
Hydramnios and uniovular twins	1	—
Fœtal infections	1	—
Prematurity	—	1
Drug poisoning	—	1
Cause unknown (possible cases of syphilis)	25	7
Total	33	18

Summary of Causes

Maternal conditions	113
Complications of labour	119
Placental conditions	18
Fœtal conditions	51

The causes of death are classified by Holland as primary and consequent. The initial or primary condition or disease

which set in train other states, which may have had the direct effect of killing the fœtus, is the primary cause, as, for example, placenta prævia. But in any case of placenta prævia the directly fatal event to the child may be fœtal asphyxia, which is therefore a cause of death consequent to placenta prævia.

The primary causes of death are given on pp. 27 and 28 : —

Albuminuria and Eclampsia

True toxæmia of pregnancy with eclampsia is liable to cause fœtal death when severe, but in cases of moderate severity the child may escape, and in mild cases the fœtal mortality is small.

The consequent or secondary causes of death may be :

1. Placental infarction, which results in a varying amount of the placenta being thrown out of action, or retro-placental hæmorrhage, which will produce the same effect. Extensive placental infarction is more commonly seen in cases of pregnancy albuminuria due to chronic nephritis, and it is here the commonest cause of fœtal death.

2. Direct action of the maternal toxins on the tissues of the fœtus is proved occasionally in eclampsia by the presence of cellular degeneration of the renal tubules and hepatic lobules. Sometimes the child when born alive may have convulsions and albuminuria immediately after birth, which is further evidence that the child may be affected directly by the maternal toxins passing through the placenta. But this cause of death is probably not frequent.

3. Obstetrical procedures for the relief of the mother may involve the fœtus in considerable risk which at times is fatal. For example, interference by inducing labour by a Champetier bag may allow the cord to prolapse, or hurried delivery by forceps may result in intra-cranial injuries. Recent work on eclampsia has shown (see p. 114) that active obstetrical procedures are seldom required for the treatment of this

condition; indeed, the maternal risk is considerably increased by active interference.

In the recent investigation of eclampsia (see p. 108) examination of 448 cases showed :—

	No. of deaths.	Mortality.
Fœtal death	156	35%
Neo-natal death . . .	50	11%
Survival	242	54%

Rather more than half the children born of eclamptic women leave the hospital alive. The fœtal mortality has a definite relation to the number of fits, for the larger the number of fits the greater the fœtal risk. Of 156 children born alive of eclamptic mothers the average number of fits was 4·6 for each delivery, while of 147 children born dead, the average number of fits in each labour was 8·4.

Fits occurring before labour have a more serious effect than intra-partum eclampsia or the toxæmia of post-partum eclampsia. Thus, of 177 births with ante-partum fits, 103 children died, a mortality of 58·2%, while, when fits first occurred during labour, in thirty-three cases the mortality fell to 27·3%, and in post-partum eclampsia the mortality was only 13%.

The effect of obstetrical procedures is well seen by the following table :—

	Total.	Survived.	Died.	Mortality.
Natural or unassisted delivery . . .	88	62	26	29·6%
Induction . . .	41	18	23	56·1%
Cæsarean section . .	74	57	17	23·0%
Accouchement force .	3	—	3	100·0%

The comparative low fœtal mortality with Cæsarean section should not, however, be regarded as a reason for performing this operation for eclampsia, in view of the very high mortality rates for the mother when this operation is chosen as the method of delivery (see p. 116). The sharp rise in the fœtal death rate for induction is noteworthy and surprising. It is probably due to the long period between the onset of the disease and delivery during which the child is *in utero*, a critical period for the child, as it is exposed for a longer time to the action of maternal toxins or placental insufficiency.

Reviewing the causes of fœtal death due to toxæmia, it is clear that the risk is greatly increased as soon as eclamptic convulsions begin, but after this the minimum amount of active interference will yield the best results. The real line of treatment, however, is the prophylaxis of the early stages of albuminuria by suitable treatment or the timely induction of labour before eclampsia supervenes.

Placenta Prævia

The inevitable separation of the placenta where it is prævia involves the child in a risk of asphyxia which is the chief cause of death, and largely beyond the control of treatment. The necessity for active treatment of the mother may involve the fœtus in a further unavoidable risk such as that of breech delivery, or, incidentally, prolapse of the cord.

A further but less common cause of death is anæmia of the fœtus, due to opening of the small branches of the umbilical artery by damage to the placenta during the course of treatment.

While it is true that sacrifice of the fœtus is justified and necessary in the interests of the mother, it is undeniable that some fœtuses are lost by injudicious treatment. In illustration of this contention Holland considers that three causes are liable to jeopardise the fœtus :—

1. Over-treatment in some cases of lateral placenta prævia where only its lower edge is on the lower segment and consequently the head is engaged and low down. Here the bleeding is only slight and never likely to be serious, even if nothing is done beyond rupture of the membranes and the application of a binder. Forcible dilatation of the os in these cases, followed by bi-polar version, is quite unnecessary for the mother and adds very considerably to the risk of the child.

2. Internal version by introduction of the whole hand through the internal os is very liable to be followed by prolapse of the cord as the hand is withdrawn from the uterus. As a rule the patient is seen before the os is sufficiently dilated for internal version, and treatment should therefore have been instituted at an earlier stage of labour. Internal version may be necessary after the expulsion of a de Ribes' bag, which is a reason for regarding the bag as an unsatisfactory form of treatment.

3. Too rapid delivery is intensely dangerous for the mother, and only less so for the child, as it is liable to result in tentorial and other cranial injuries. Of thirty-two fresh fœtuses born dead in placenta prævia labour no less than 50% showed tentorial tears, with cerebral hæmorrhage in all but three. Whether all the fœtuses were killed by these injuries is not known, but in any case they sustained injuries during delivery sufficient by themselves to have killed them. It cannot be emphasised too often that rapid delivery in placenta prævia is a most dangerous procedure, both for the mother and child. But whatever be the methods of treatment adopted, the fœtal mortality must be high, partly due to the unavoidable prematurity, partly because the inevitable separation of the placenta in central and marginal cases is a cause of a dangerous degree of asphyxia. Thus, of 100 consecutive cases at Queen Charlotte's Hospital the still-births amounted to 45% and neo-natal deaths to 13%, or a total mortality of 58%.

Placenta prævia is a cause of fœtal death over which we

have little control by ante-natal care, but much more by a wise choice of the method of delivery and skill in carrying it out.

Contracted Pelvis

Difficult labour due to contracted pelvis is obviously a source of great danger to the fœtus, partly owing to other complications arising from the condition of pelvic contraction such as prolapse of the cord, partly owing to the obstetric interference necessary for delivery.

Out of Holland's series of 300 dead fœtuses, twenty-four were killed by some consequence of contracted pelvis, or a mortality of 8% due to this cause. In half of these dead fœtuses there was evidence of cranial stress, as shown by tentorial tears and hæmorrhage.

Viewed from another angle, the importance of contracted pelvis may be appreciated by the following experience at Queen Charlotte's Hospital during the three years 1920–1922 :—

Method of Delivery.	No. of cases.	Fœtal deaths.	Mortality.
Forceps without induction .	38	11	29·0%
Craniotomy . . .	18	18	100·0%
Induction	226	34	15·0%
Cæsarean section . .	127	11	8·6%

The average mortality of the fœtus in 409 labours with contracted pelvis was thus no less than 37%, a figure which gives some measure of the great risk to the fœtus in the presence of pelvic contraction.

A more instructive analysis, and one which justifies a less depressing view, is to contrast the risk of those patients who have and who have not been subjected to ante-natal examination.

It is justifiable to assume that all those patients who had an induced labour or Cæsarean section were examined during pregnancy and thereby discovered as having pelvic contraction which required treatment, while, on the other hand, we may fairly add those patients who were treated by forceps without induction, or craniotomy as those who had either no ante-natal examination or no prophylactic treatment based upon the results of examination.

Method of treatment.	No. of cases.	Fœtal deaths.	Mortality.
No ante-natal care . .	56	29	52·0%
With ante-natal care . .	353	45	12·0%

It will be observed that where the patient comes into labour at term without having been examined or treated, the loss of fœtal life is more than four times as great as when the patient is properly watched and treated as the merits of the case demand. In contrast to placenta prævia we have, in contracted pelvis, a condition, therefore, which responds in a gratifying manner to watchful care and timely prophylaxis before full term by induction of labour, or, at term, by a justifiable Cæsarean section.

Breech Presentation

Of all the mal-presentations, the breech is by far the commonest, and a source of considerable risk to the fœtus ; and in nearly all Holland's cases there were found more or less extensive tears of the tentorium. This is an unexpected and remarkable fact, for it has been generally believed that the loss of life was chiefly due to asphyxia caused by delay in delivery of the head. The almost constant presence of intra-cranial injuries and hæmorrhage suggests strongly that the risk of asphyxia is not comparable to that of fatal

cranial injuries caused by too rapid delivery of the head in an attempt to avoid asphyxia by delay.

The contrast between vertex and breech labour which probably explains why the head can tolerate so much more stress and moulding in the former than the latter is that in vertex labour the alterations in shape of head are slow and gradual, while in breech labour the after-coming head is quickly dragged through the pelvis and out of the insufficiently dilated vulval orifice. It is most important to realise that the head can tolerate considerable moulding if the stress is applied gradually as in vertex labour, by giving time for the dural septa to stretch without laceration, but sudden severe compressions as inflicted by the rapid delivery of the after-coming head are apparently very liable to tear the septa rather than stretch them and thus produce a fatal hæmorrhage.

Holland states that out of sixteen dead fresh fœtuses delivered by the breech, no less than fourteen exhibited intracranial injuries, and on this experience he recommends a reorientation of our views concerning the management of breech labour.

Hitherto it is the fear of asphyxia by pressure on the cord while the trunk or head is in the pelvis, combined with premature efforts at inspiration, which has prompted us to deliver as quickly as possible after the birth of the umbilicus. But it is certain that a fœtus can tolerate at least ten minutes of anaerosis without losing its life. This contention is illustrated by the pale apnœic baby born after morphia-scopolamine narcosis lying motionless for as much as fifteen minutes, but steadily maintaining its heart and finally establishing spontaneous respiration. Death from morphia apnœa in the new-born is a rare event, and of a series of experimental cases of " twilight-sleep " at Queen Charlotte's Hospital no child died from this cause. It would appear, therefore, that the greater danger to the child in breech labour arises not from asphyxia but from cranial injuries due to too vigorous

efforts to avoid asphyxia, and therefore a mean course should be held between Scylla and Charybdis, by slow and gentle efforts escaping the dangers of both. A further means of preventing too great compression of the head by the rigidity of the vulval orifice is by incision of the postero-lateral margin backwards and outwards for about an inch, just as the posterior buttock is distending the perinæum. The vulval outlet is thus considerably increased, and delivery of the head is correspondingly easier.

Syphilis

It has been long known that syphilis is a potent cause of the loss of fœtal life both by miscarriage, premature birth and neo-natal death, but the exact amount of fœtal death attributable to syphilis is not an easy figure to arrive at. Not only is the problem difficult from the statistical point of view, but there are considerable clinical and pathological difficulties in recognising syphilis in many infected still-born fœtuses. During recent years Browne, of Edinburgh, and Eardley Holland have carried out exhaustive researches on this question and have produced certain pathological criteria by which doubtful cases may be tested. Of Holland's series of 300 dead fœtuses collected from many different areas of London, there were thirty-seven spirochæte-positive cases, five other certain cases, six probable, and fourteen doubtful cases. This amounts to forty-two proved cases of syphilis, or 14%, and including the six probable cases, 16% of fœtal deaths attributable to syphilis.

Diagnosis of Fœtal Syphilis

The presence of spirochætes in the fœtal tissues is, of course, positive proof of the existence of syphilis. The organism may be identified by the Levaditi method of staining by silver nitrate or the simpler dark background illumination. The latter method is simple and quick, and

will usually reveal the presence of the spirochæte, but if it cannot be found the confirmatory method of Levaditi should be employed. The spirochæte is most easily found in the liver and spleen, but in some fœtuses it can be found in every organ and also the epiphyseal line of the long bones.

The *indirect evidence* of syphilis can be classified as follows :

1. Positive maternal Wassermann.
2. Syphilitic osteo-chondritis.
3. Increase of weight and histological changes in the placenta.
4. Enlarged liver and spleen with histological changes.
5. Histological changes in certain other viscera.

1. The Maternal Wassermann Reaction

For many years there has been a disagreement on the reliability of a negative Wassermann reaction in pregnancy as a diagnosis of the absence of syphilis. This has arisen partly because of the anomalous nature of conceptional syphilis, partly because some still-born fœtuses born of women with negative Wassermann reaction have exhibited certain post-mortem signs which have been regarded as evidence of fœtal syphilis, but which are probably due to other causes.

The one certain means of determining the reliability of the maternal Wassermann is to study it only in relation to those fœtuses who are known certainly to be syphilitic, *i.e.*, the spirochæte-positive fœtus. By disregarding all other fœtuses, however suggestive be their secondary or indirect evidence of syphilis, we can be sure of dealing with certain fœtal syphilis.

F. J. Browne (2) states that he has never yet met with a spirochæte-positive fœtus whose mother had a negative Wassermann test, and in all cases where the mother had a

negative Wassermann reaction spirochætes could not be found in the fœtus. Holland is not able to make so definite a statement, but describes the Wassermann reaction as being positive in thirty-five out of thirty-seven (95%) spirochæte-positive fœtuses. The two negative women were re-examined, but each test proved to be negative. This is an admittedly rare phenomenon in the experience of all workers on the subject, and we are justified in concluding that the Wassermann reaction is not modified to any important extent by the occurrence of pregnancy.

In general we may say that a woman with a positive Wassermann reaction will bear a definitely syphilitic fœtus, but if the Wassermann reaction be negative there will be no absolutely certain evidence of syphilis in the fœtus.

Clinical difficulties arise in those cases where the woman has a " bad obstetrical " history, *i.e.*, she describes a series of miscarriages, still-births and premature children dying soon after birth, but in whom the Wassermann reaction is negative repeatedly and no spirochætes can be found in the products of conception. A diagnosis of syphilis on the clinical history is almost irresistible, but increasing experience of the subject is beginning to show that, whatever the obstetrical history may be, a diagnosis of syphilis cannot be positive unless there are, *in addition*, either a positive maternal Wassermann reaction or spirochætes in the fœtal viscera. These long-standing cases are admittedly very difficult. It is possible that further work may show that the fœtus is still liable to secondary changes of its viscera for long after the maternal Wassermann is negative and the organism has ceased to exist in the spirochæte form, but it should also be borne in mind that there may be other ante-natal pathology, besides syphilis, capable of producing " bad obstetrical " histories and fœtuses with secondary changes in the viscera resembling those of syphilis. In the meantime it is safe to assume that the only sure evidence of syphilis is the positive Wassermann reaction and the presence of spirochætes.

2. Osteo-Chondritis

Osteo-chondritis is an inflammation of the epiphyses of long bones characteristic of congenital syphilis. The naked eye appearances are as follows : The earliest change is the yellow line of provisional calcification becoming abnormally deep. This may be observed while the line of junction between the epiphysis and diaphysis is still regular and unbroken. Later the epiphyseal line becomes irregular or dentate by reason of ossification developing along the course of the larger vertical vessels and not along the smaller vessels which undergo some occlusion by the syphilitic process (3).

Holland found irregularity of the epiphyseal line in thirty-six out of thirty-seven spirochæte-positive fœtuses, or 97%. Most other writers who have made microscopical examination of the epiphysis in congenital syphilis also regard thickening and irregularity as very strong evidence of syphilis.

3. Placental Changes

There has been much confusion on the question of the changes in the placenta caused by syphilis on account of their variability and the uncertainty of the positive diagnosis of the presence of syphilis in the fœtus. Since the presence of spirochætes has been regarded as the only reliable criterion by which to judge the value and significance of secondary changes, our knowledge of these changes in the placenta is becoming more definite. It is important to be able to make a tolerably sure diagnosis from examination of the placenta, as it is often the only histological material available, and it is equally necessary to realise that many conditions found in the placenta are not syphilitic.

(*a*) **Naked-eye Appearance.**—The most careful examination of the placentas of proved syphilitic fœtuses fails to find any certain naked-eye changes. Neither the maternal surface nor the sliced cotyledon exhibits any peculiar lesion or alteration from the normal which is only found

in syphilis, and some conditions such as infarcts, grittiness and greasiness, pallor of the cotyledons, are more commonly found in placentas of non-syphilitic fœtuses. It may be stated, therefore, that no diagnosis can be made by the naked-eye inspection alone.

(*b*) **Weight and Size.**—Much importance has been ascribed to a consideration of the weight of the placenta, but careful investigation serves to show that changes in weight can occur in uninfected as well as syphilitic fœtuses.

It is usual to describe the weight of the placenta as the weight ratio, *i.e.*,

$$\left\{\frac{\text{Weight of fœtus}}{\text{Weight of placenta}}\right\} = \text{Ratio.}$$

Premature fœtuses have a relatively heavier placenta than full term fœtuses, *i.e.*, the fœtus grows out of proportion to its placenta towards the end of pregnancy, and in estimating the weight of the placenta of a premature fœtus this fact should always be borne in mind.

The following table is given by Holland to show the comparison of the weight ratio of non-syphilitic and syphilitic placentas.

	No. of Placentas examined.	Weight of Fœtus.			
		Under 1,800 grm.	1,800-3,000 grm.	Over 3,000.	Mean for all.
Fresh non-syphilitic .	94	6	8	8	8
Macerated non-syphilitic.	64	6	8	10	8
Syphilitic	34	5	7	—	6

It will be noted that there is little difference in the weight ratio, but that the mean figure shows that the placenta tends to be slightly heavier in syphilitic fœtuses. Extreme heaviness is found in both categories of placenta, and, on the other hand, ratios of ten, eleven and twelve, are occasionally

observed with definitely syphilitic fœtuses. The weight may be considerably increased by hæmorrhage into, or œdema of the placenta in toxæmia and eclampsia. Expressed in figures, only 65% of positively syphilitic fœtuses possessed placentas heavier than normal. Mere heaviness is therefore of no value for purposes of diagnosis.

(*c*) **Histology.**—A more reliable guide to the true condition of the placenta is its histology, though even so it must be admitted that not all the placentas of certainly syphilitic fœtuses exhibit characteristic changes. The full term live child born of a syphilitic mother will probably possess a placenta which shows no changes either by naked eye or microscopic examination, but the placenta of the premature macerated fœtus will in nearly every case show the typical histological changes.

1. The villi are enlarged by an increase in the cells of the stroma. They appear, therefore, to be closely packed together with a corresponding diminution of the intervillous spaces. This change may affect the whole placenta, or only certain of the cotyledons.

2. Absence of the capillary vessels of the villi, giving them a homogeneous cellular appearance. Normally the cross section of the villus shows two large spaces filled by yellow blood discs and lined by endothelium, with sparsely scattered stroma cells around these vessels, but in the syphilitic placenta the villi usually show no vessels, or very small vessels. The large primary vessels of the cotyledon, according to some writers, exhibit a thickening resembling endarteritis, but the walls of the capillaries are not thickened and consist only of endothelium.

The absence of capillaries from the swollen villi is due to the fact that they have never been vascularised by the down-growth of capillaries from the parent branches of the umbilical arteries.

3. Collections of small round cells are occasionally found in the decidua or chorion resembling a miliary abscess or

microscopical gumma. They are evidence of the chronic inflammatory process of syphilis.

The above histological changes are found in 61% of spirochæte-positive fœtuses, and in 90% of placentas showing these changes the fœtus yielded spirochætes (Holland). Histological changes are therefore of considerable value as indirect evidence of syphilis, though, unfortunately, when it is most wanted, *i.e.*, in surviving children, they are seldom present.

4. *Enlargement of the Liver and Spleen.*—There is always some enlargement of the liver in the macerated syphilitic fœtus, but there are many cases of enlarged liver which are not syphilitic. Simple enlargement of the liver, therefore, is useless by itself as evidence of syphilis, but when associated with other signs it is of confirmatory value.

Similarly, enlargement of the spleen is nearly always found in syphilitic fœtuses, but, as in the case of the liver, other causes than syphilis will produce a large spleen.

Fœtal Head Injuries in Labour

The important part played by intracranial injuries in causing intra-partum or neo-natal death has been emphasised by Holland in his recent report on the Causation of Fœtal Death. Careful dissections were carried out by him and his fellow workers, which have shown not only the frequence of head injuries, but also the uniformity of the nature of the injuries and the causes which have produced them. So important is a proper understanding of the mechanism of the stresses applied to, and the strains received by, the fœtal skull for an intelligent appreciation of the dangers of difficult labour, that I shall give in some detail the results of Holland's work.

Forces acting on the Fœtal Cranium

During its passage along the birth canal the cranium is exposed to a general compressive force acting in all directions,

except the lowest point, at right angles to the surface and tending to reduce the actual volume of the head by expressing out of it blood and cerebro-spinal fluid. The magnitude of this compressive force will vary at different points of the child's head roughly proportionately to the length of the diameter of the skull at right angles to any given point. Thus the occipito-frontal diameter of $4\frac{1}{2}$ in. being relatively long and thrown across the birth canal in a posterior position will provoke the application to the frontal and occipital bones of the maximum pressure of the maternal parts. The so-called engaging diameter, *e.g.*, the sub-occipito-bregmatic in the L.O.A. position, or the mento-vertical in a brow presentation, will therefore bear the brunt of the compressive force applied to the skull, and endure the maximum strain. The effect of this stress will be to reduce the longitudinal diameter in one direction, and produce compensatory elongation in the diameter at right angles to it. This process is ordinarily referred to as "moulding." The observed effects, or, in other words, the degree of moulding and the extent of any damage wrought by the stress, will depend upon :—

1. The amount of the stress, or clinically, the difficulty of the labour as regards size of pelvis, size of head and presentation.
2. The direction in which the stress acts, depending upon the degree of flexion or extension.
3. The degree of "softness" of the fœtal head, which chiefly varies with its maturity.
4. Whether the compressive forces act gradually, as in a vertex, or suddenly, as in a breech presentation.

The head is so constructed that it can bear a considerable degree of gradually applied force with consequent change in shape without any permanent effects whatsoever, but there is a limit to its capacity to bear stress, beyond which something in the skull must break, with effects which are nearly always, if not always, fatal.

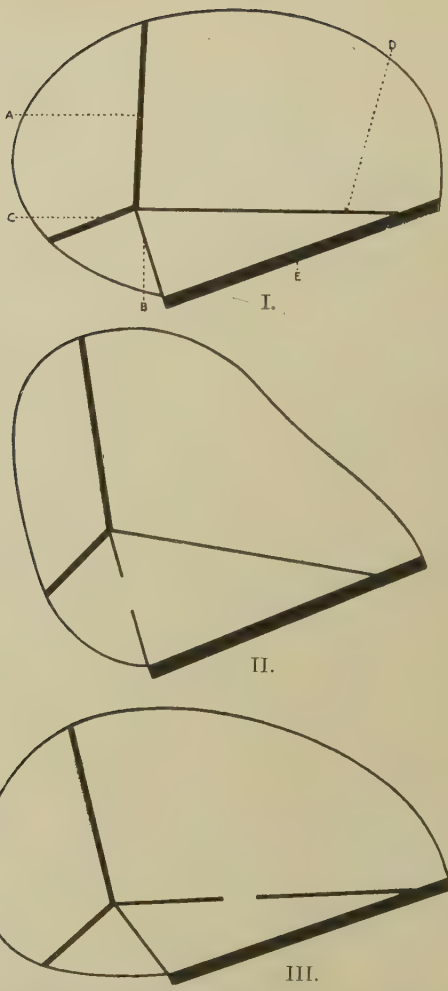

FIG. 1.—Diagrammatic outlines of head and septal system of dura matter. The lines representing the septa show their chief directions of strength : (A) falx cerebri, (B) middle (vertical) part of tentorium cerebelli, (C) line of junction of tentorium and falx, (D) anterior (horizontal) part of tentorium cerebelli, (E) base of skull. I. Normal shape of head. II. Shape of head during compression in occipito-frontal diameter ; greatest strain on vertical part of tentorium. III. Shape of head during compression between vault and base ; greatest strain on horizontal part of tentorium. (Holland.)

Mechanism of the Fœtal Skull

From the mechanical point of view the skull consists of an elastic vault composed of six bones or parts of bones which are jointed loosely and are themselves flexible, fixed by joints upon a rigid non-compressible base. Excessive alteration

Fig. 2.—Semi-diagrammatic drawing to show arrangement of fibres in falx and in superficial layer of tentorium, after removal of parietal and part of occipital and frontal bones. (A) points to black dotted line indicating floor of straight sinus; (B) points to white dotted line indicating position of deep horizontal band; (C) points to anterior vertical band. (Holland.)

in relative position of the bones, and so of the shape of the skull, is prevented partly by the limitations of their own flexibility and jointing structures, partly by the intra-cranial septa of dura mater which are disposed in two main planes, one vertical and longitudinal (falx cerebri), and one transverse and horizontal (tentorium cerebelli) (Fig. 1, I., II., III.). While

alteration in shape is permitted by the flexibility of the component parts, actual reduction in size is permitted to a very small extent by the expression out of the skull of blood and cerebro-spinal fluid and a small portion of the medulla

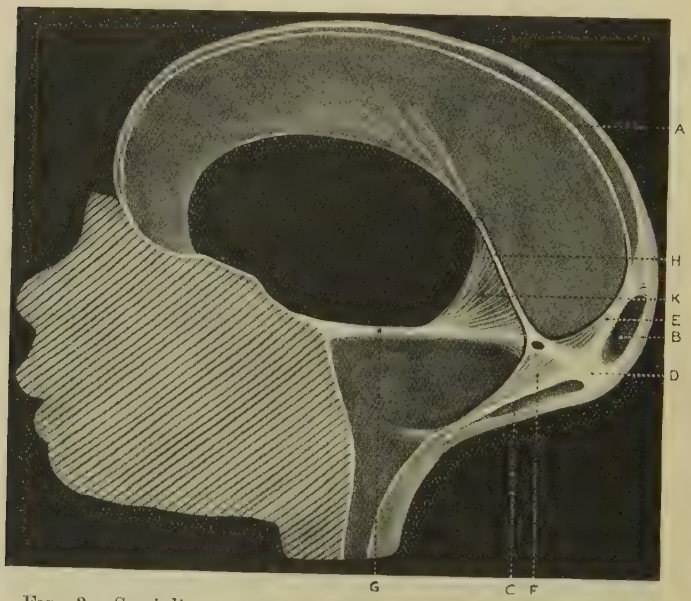

FIG. 3.—Semi-diagrammatic drawing to show arrangement of strengthening bands of antero-posterior system. The head has been bisected sagitally immediately to the left of the falx cerebri. (A) points to superior longitudinal sinus; (B) to torcular herophili; (C) to occipital sinus; (D) to main mass of fibrous tissue; (E) to band descending from posterior end of superior longitudinal sinus; (F) to falx cerebelli; (G) to deep horizontal band; (H) to white line; (K) to triangular area in anterior part of tentorium. (Holland.)

into the foramen magnum. For practical purposes, however, the alteration in shape is the essential and important point. Normal degrees of moulding in ordinary vertex labour and expulsion of the after-coming head involve compression of the long diameter, causing a certain small decrease in its length and a corresponding increase in the opposite or

vertical diameter. The bulk of this change in shape is accomplished by the swinging backwards of the occipital plate, and passage of this bone and the frontal bones beneath the parietals. But it is probably the dural septa—the falx cerebri and tentorium cerebelli—which restrain excessive movement of the skull bones, and so act as a check to extreme

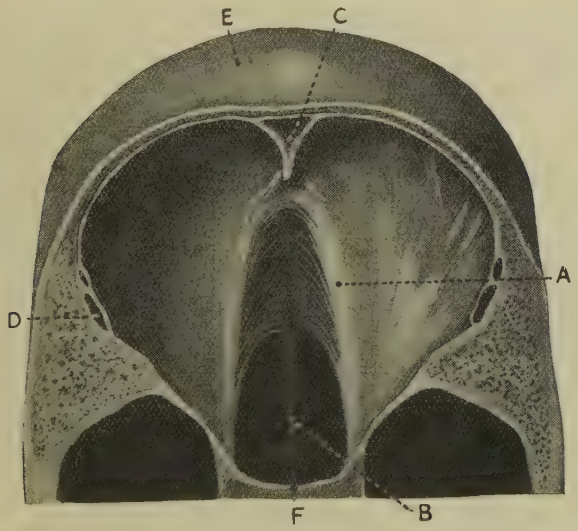

FIG. 4.—Drawing of under-surface of tentorium cerebelli to show the origin and course of the deep horizontal bands. The head had been sawn through horizontally just below the level of the tentorium. (A) points to deep horizontal band of right side; (B) to posterior end of free edge of falx cerebri; (C) to torcular herophili; (D) to left lateral sinus; (E) to occipital bone; (F) to body of sphenoid. (Holland.)

and dangerous moulding. The arrangement of the dural septa will be recalled by the diagrams Figs. 1, 2 and 3.

It will be observed that if the head be compressed in the occipito-frontal diameter as in Fig. 1, II., there will be elevation of the dome of the skull and consequent tension of the falx and tentorium at the points indicated; while, if the head be compressed between the base and vault (Fig. 1, III.), as in face

and brow presentations, there will be elongation of the occipito-frontal diameter and tension of the falx and tentorium at their free borders.

Beyond a certain degree of tension there must be rupture of these restraining septa either complete or incomplete.

FIG. 5.—Complete tears of tentorium and extensive tearing of falx. In the tentorium there are two perforating tears on the left side ; one is a ragged tear starting below the base of the anterior vertical band and extending outwards almost to the lateral border of the tentorium. The other is a large perforation through the superior wall of the left lateral sinus at its termination in the torcular herophili. (Holland.)

By rupture very serious damage has been inflicted on the skull partly because a variable amount of blood will escape from the torn vessels of the septa, partly because further and dangerous movement of the skull bones can only take place with the consequent risk of direct injury of the brain.

Without going into a complete anatomical description of the

dural septa, it will be sufficient to indicate their main disposition and relationship to the venous sinuses by Figs. 2 and 3.

It will be noted that the tentorium lies roughly at right angles to the falx and is attached to it longitudinally in the middle line, so that tension on the falx in an upward direction tends to pull the tentorium up and exert a stress chiefly at

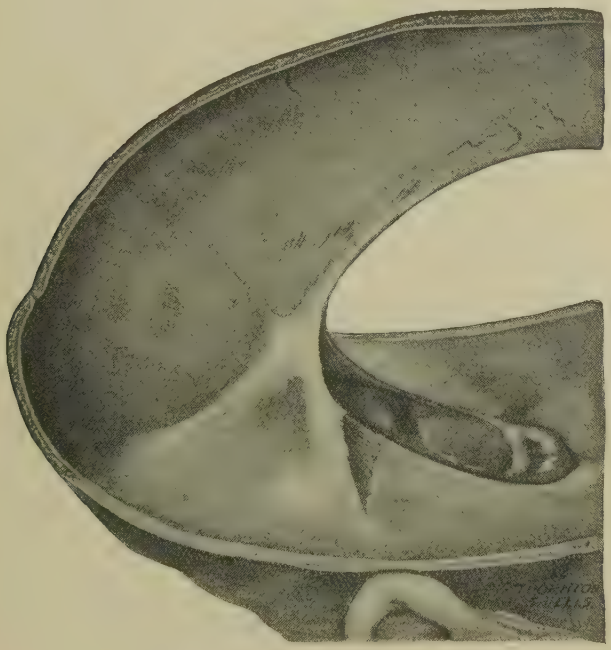

FIG. 6.—Complete tear of tentorium cerebelli with separation between superficial and deep layers. The anterior vertical band is widely separated from the deep horizontal band. (Holland.)

its free border. To meet the forces applied during moulding special fibrous thickening of the septa appears along those lines exposed to special strain, comparable to the deposits of cancellous bone in the shafts of certain long bones to provide against special strains.

A. **The Antero-Posterior System.**—The main mass of

fibrous tissue is a central portion attached to the occipital bone at the torcular herophili, and from this passes :—

1. A strong band upwards and backwards through the longitudinal sinus (Fig. 3, A).

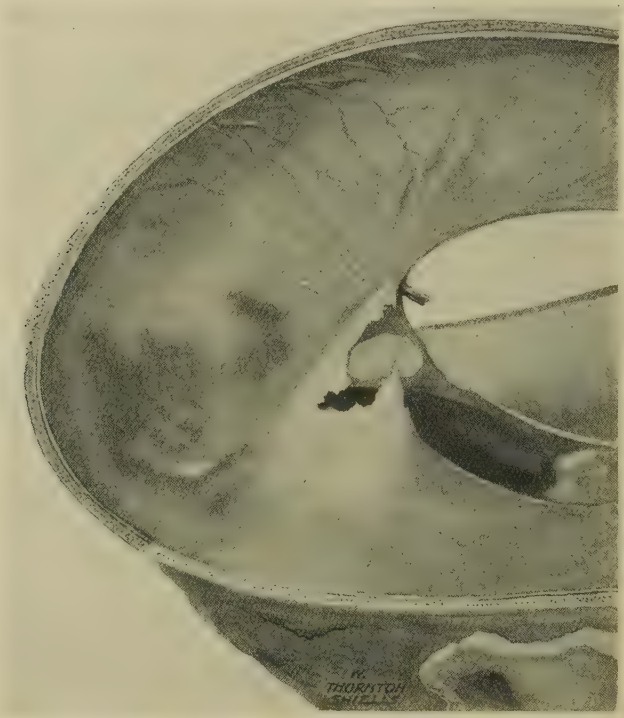

FIG. 7.—Complete bilateral tear of the tentorium cerebelli. On the right side the anterior vertical band has been torn through ; on the left side the anterior border of the band has remained intact. (Holland.)

2. A band forwards along the line of junction of the falx cerebri and the tentorium (Fig. 3, H).

3. A band running downwards and forwards around the occipital sinus and forming the falx cerebelli (Fig. 3, F).

4. Two paired fan-shaped processes of fibrous tissue

passing forwards along the inferior aspect of the tentorium, forming the lateral portions of its free edge, and inserted into the anterior clinoid processes (Fig. 4, A). These important bands are termed the inferior horizontal bands of the tentorium (Fig. 2, B, and Fig. 3, G).

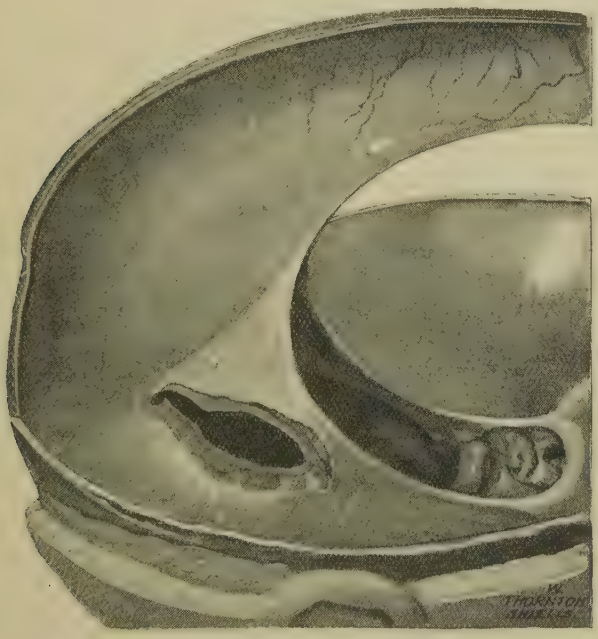

Fig. 8.—Complete tear of tentorium cerebelli. On right side of the tear is a large perforation and involves all the superficial strengthening fibres of the tentorium and the base of the deep horizontal band. (Holland.)

B. **The Vertical System.**—1. A fan-shaped band of fibres in the falx cerebri originating from its middle two-thirds along the longitudinal sinus and passing downwards, converging on a mass of fibrous tissue occupying the anterior portion of the line of junction of the falx and the tentorium (the white line) (Fig. 2).

2. A similar fan-shaped band in the tentorium originating from the region of the lateral sinus and passing inwards to converge on the fibrous node described above (vertical band of the tentorium) (Fig. 2, C). This band forms the free border of the tentorium in its posterior part, and is subjected to considerable strain in nearly every labour.

The Nature of the Septal Lacerations

Dissection of the fœtal head which has suffered much moulding by removal of the parietal and half the frontal bones, demonstrates very clearly the nature of the septal injuries. The critical area of the tentorium is a triangular area, shown in the diagram Fig. 2, bounded above by its attachment to the falx cerebri, below by the horizontal band of the tentorium and in front by its curved free edge. Nearly all septal injuries involve this area of the tentorium, and consist of tears either of the superficial (Fig. 6) and deep layers or both. The free edge itself may be broken (Fig. 7), or the tear may appear as a hole immediately behind the free border (Fig. 8). Sometimes the superficial and deep layers of the tentorium are separated with laceration of the intervening areolar tissue and small vessels and formation of a hæmatoma, which appears as a dark plum-coloured stain of the tentorium. The falx cerebri is only occasionally lacerated and always in association with tentorial tears. The injuries take the form of oval holes in the middle two thirds (Fig. 4).

Sub-dural Hæmorrhage

Most cases of intracranial injury due to excessive moulding are associated with a variable amount of subdural hæmorrhage. This may be only a few drops of blood or a very large extravasation extending in all directions. By the careful examination of small hæmorrhages, Holland was able to observe that they all originated from one vessel or group of vessels—the vein of Galen and its tributaries The area

where the blood is found is bounded in front by the transverse fissure, by the upper part of the tentorium behind, below by the pons Varolii, and laterally by the mesial surfaces of the cerebellum.

The vein of Galen passes backwards from the velum interpositum above the corpora quadrigemina to end in the straight sinus at the point where the free border of the falx cerebri meets the tentorium. The diagram will show the normal relationship of the vein with reference to the dural septa, while Fig. 7 will show the alteration in direction caused by the tension on the tentorium in excessive moulding. Two results follow. Its junction with the straight sinus is sharply kinked, and either the vein itself or its tributaries is liable to be torn with effusion of blood from the engorged vessel. The most common result is rupture of its tributaries, particularly those running into it from the upper surface of the cerebellum.

Clinical Features

Out of 167 fresh still-born fœtuses examined by Holland and his fellow-workers, no less than eighty-one, or 48%, showed tears of the tentorium. The great majority also had subdural hæmorrhage of variable amount, but the falx cerebri was torn in only six cases. It is obvious, therefore, that this particular form of intra-cranial injury must be a very frequent cause of fœtal death, and probably accounts for the majority of still-births due to difficult labour and breech delivery.

In this series there were forty-four cases of vertex presentation, of which twenty-five were cases of forceps delivery and nineteen of natural delivery. It is easy to understand how the forceps can produce the stress necessary to cause the septal tears. The instrument may be applied over or near the antero-posterior diameter, producing thereby elevation of the dome of the skull and undue tension on the falx and

tentorium, or it may be applied to a premature child whose head is softer and more plastic than at full term, or it may be pulled with too much force. We have already noted how the application of stress to the head too suddenly, as in delivery of the after-coming head, is very liable to cause tentorial tears. Similarly, the too sudden delivery of the head by forceps, especially when applied to the head before it has properly moulded through the brim, is liable to cause injury.

The lesson taught by these investigations is emphatic. The forceps should be applied as nearly as possible in the coronal diameter of the head, and, if possible, only after sufficient time has elapsed in the second stage for moulding to occur naturally. Further, the degree of traction should be as light as possible with frequent intervals of rest corresponding to the incidence of pains and relaxation, and delivery should be effected slowly and gradually.

It is less easy to understand why the head should be injured by natural delivery, but in this investigation there were nineteen, *i.e.*, not many less than the forceps group. Some could be explained by very rapid or difficult labour, great resistance of the soft parts, as in one case where the vaginal outlet was considerably narrowed by a previous operation of colpo-perinæorrhaphy.

It is suggested that some damage to the fœtal skull as it is being delivered can be imparted by too great pressure by the hand applied to the frontal bones in an attempt to prevent rupture of the perinæum. Under these circumstances the pressure is applied in the antero-posterior diameter, which is the dangerous direction. The high rate of tentorial tears in breech delivery has already been commented upon.

The Effect of Tentorial Tears and Sub-dural Hæmorrhage

It is impossible to state how far the fœtal death is due to the actual injury of the tentorium and hæmorrhage, or

whether a child sustaining a tear is capable of surviving. We have no accurate knowledge of after-histories confirmed by post-mortem examination of the tentorium in later life.

While it is obvious that a large hæmorrhage would be a most serious lesion, it does not seem clear that a simple tentorial or falcial tear without hæmorrhage would be sufficient to cause death. It is probable that the septal injury is the most obvious of many effects caused by great cranial stress, and that actual death may be due to other less obvious conditions. For example, excessive moulding will cause considerable increase of intra-cranial pressure with embarrassment of the vital medullary centres, or the actual crowding of the medulla into the foramen magnum may have a similar deleterious effect. The important point to remember is that cranial stress is dangerous beyond a certain amount, and that this limit is comparatively easily reached by some forceps extractions and many cases of breech delivery.

How far a child is capable of surviving an intra-cranial injury is not known. It is certain that small hæmorrhages and tears are not incompatible with life, because post-mortem examination of children who have survived a few days reveals the existence of these injuries, and Holland reports a case of an autopsy on a child of six months which discovered a large and complete tear of the tentorium with healed edges.

A more important question is whether such intra-cranial injuries lead to any mental impairment in the case of those children who do survive. No accurate information on this subject exists, but Cameron (4) believes there is evidence that these children develop the perception of environment later in life than normal children and so appear to be " backward." In addition to a certain amount of apparent mental sluggishness, there may persist some spastic paralyses which are the result of permanent damage to the Rolandic area, but it seems quite certain that intra-cranial birth injuries have no relation whatever to cerebral diplegia or congenital idiocy.

Placental Causes

The Weight of the Placenta

Considering non-syphilitic fœtuses, the weight ratio of the placenta to the fœtus in both fresh and macerated fœtuses is the same, *i.e.*, about eight; or in other words, the fœtus is, on the average of all cases, eight times as heavy as its placenta.

Prematurity, however, has an important influence on the weight ratio, and this should always be borne in mind when considering the placenta of a premature fœtus as being possibly syphilitic.

The following table illustrates this point (Holland):—

Fresh

	Under 1,800 grm.	1,800-3,000 grm.	Over 3,000 grm.
Mean ratio . .	6	8	8

Macerated

	Under 1,800 grm.	1,800-3,000 grm.	Over 3,000 grm.
Mean ratio . .	6	8	10

It will be noted that full-term macerated fœtuses are liable to have an unusually light placenta (ratio = 10), and the important question arises as to whether the inadequacy of the placenta may not have been a cause of failure to develop sufficiently, and ultimately of intra-uterine death. Exactly how much of the placenta is necessary for fœtal growth and

existence cannot be known, but it is certain that there must be a very wide margin of safety. Thus, Holland reports a case of a fœtus which lived until the end of pregnancy, but died during labour, where two-thirds of its placenta was destroyed by infarction. This is an extreme case, though this degree of placental insufficiency was compatible with fœtal development, probably because it was gradually produced by the slow process of infarction, but where two-thirds of the placenta is suddenly thrown out of action by hæmorrhage behind it, or separation in a case of placenta prævia, the child would have no chance of survival.

The chief importance of a small placenta lies in the reduced "margin of safety" available to the fœtus should any accident such as separation by hæmorrhage or infarction throw any considerable portion out of action. A small placenta can suffer very little such accident or disease without imperilling the life of the fœtus. Holland reports ten cases of macerated fœtus, with unusually small placenta where no other cause could be found, out of a total of 300 still-born fœtuses. This is suggestive that smallness of the placenta may be incompatible with the late development of the fœtus, and may be tentatively regarded as an undiagnosable cause of intra-uterine death during the last few weeks of pregnancy.

Placental Infarction

1. **Red Infarction.**—Localised death of placental tissue results in the formation of a red infarction, which is the first step in a series of degenerative changes of the dead placental tissue. The placenta itself is nourished by the maternal blood in which its villi float, and any interference with the normal bathing of the villi by the maternal blood will cause the death of those villi.

It is found, therefore, that the red infarct invariably subtends a small retroplacental hæmorrhage or hæmatoma, the extent of which determines the area of the infarct. Red

infarcts are often missed when inspecting a fresh placenta at birth, because the colour of the two is not greatly different, but when teased in water, or if the fœtal blood is cleared out of the placenta by injection of saline along the umbilical artery of the cord, the infarcted area will remain as an intensely red pyramidal area with its base at the maternal surface.

Microscopic examination reveals a great congestion of the villous capillaries, with œdema and swelling of the Wharton's jelly. The intervillous spaces are reduced and the whole are glued together into a fleshy mass by intervillous fibrin and blood clot. Red infarcts are commonly found in toxæmic albuminuria and nephritis, but the association is by no means universal. Whatever the systemic disease of the mother, the immediate cause is retro-placental hæmorrhage. In nearly all cases of red infarction there is some obvious maternal condition present, such as albuminuria, eclampsia, accidental hæmorrhage or retro-placental hæmatoma. Red infarcts as a direct cause of death will operate only according to their size. Where only small infarcts exist the fœtus has perished from the primary maternal condition, such as toxæmia.

2. **White Infarction.**—A later stage of localised death of the placenta is white infarction. With time the initial red infarct becomes avascular and decolorised, and appears as a firm white mass. There may be many or single small ones, or a large piece of placenta may be infarcted. All cases of excessive white infarction are associated with definite maternal disease, nearly always albuminuria with or without accidental hæmorrhage. Syphilis does not appear to be particularly associated with infarction.

General Conclusions

While a large number of more or less rare conditions are capable of causing fœtal death, the outstanding fact of

Holland's inquiry was that more fœtuses are killed by complications of labour than died during pregnancy from maternal or fœtal disease. A summary of the causes, which will set forth this conclusion, is as follows :—

Complications of labour (including ante-partum hæmorrhage and post-maturity of the fœtus)	51%
Syphilis	16%
Toxæmia of pregnancy	10%
Chronic, renal and other maternal diseases	2%
Placental conditions	6%
Fœtal deformities	5%
Cause of death unknown	11%

The inevitable conclusion to be drawn from this survey is that a large number of fœtal deaths could be prevented by ante-natal recognition and treatment of maternal diseases, and by better management of labour.

The great example of ante-natal treatment is that of syphilis. Timely recognition and treatment by a suitable injection, even when only carried out during the later weeks, is of great value in entirely eliminating the disease from the new-born. When it is recalled what a mass of ill-health, degeneracy and expense, apart altogether from the loss of fœtal life, can be laid at the door of congenital syphilis, it will readily be conceded that the result of ante-natal treatment of this condition is one of the triumphs of preventive obstetrics.

Toxæmia of pregnancy can be also brought under control to a great extent, though perhaps not to the same degree as syphilis. Much can be done to arrest the toxæmic process if recognised early, or to save the child by induction of premature labour if, in spite of treatment, the disease progresses. The case of chronic nephritis is more difficult, but here again it may be possible to save the child if induction can be done

not later than the thirty-sixth week. Ante-natal examination and diagnosis can also save a very large number of fœtal deaths due to mechanical difficulties in labour if it is combined with active treatment in the shape of induction of labour or Cæsarean section.

Similarly, the difficulties and risks of breech presentation may be corrected in many cases by external version during pregnancy.

The conditions not recognisable during pregnancy, such as placenta prævia, delayed rotation of occipito-posterior presentations and prolapse of the cord, all have a better chance of successful treatment if diagnosis be made during the early stages of labour and treatment adopted before exhaustion supervenes. While it is necessary to stress the importance of ante-natal examination and treatment, it is also necessary to emphasise the great need of early diagnosis in labour. It is perhaps more due to a lack of early recognition of abnormalities in labour than inability to carry out suitable treatment for them that both fœtal and maternal life are sometimes lost.

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CHAPTER IV

THE CHEMISTRY OF THE BLOOD AND URINE IN PREGNANCY

The problems presented by the toxæmias of pregnancy have been responsible during recent years for stimulating interest in the chemical conditions of the blood and urine. Very much analytical work has now been done on the blood and urine of normal and toxæmic pregnancy—partly as an attempt to elucidate the cause of toxæmia, partly as an effort to formulate some co-ordination between chemical and clinical phenomena which might act as a guide to treatment and an indication of prognosis.

It soon became apparent that though certain chemical changes were usually discovered to be fairly constant in toxæmia, yet little progress towards the solution of the problem of the nature and origin of the cause was achieved. Pure analysis has failed to reveal anything positive, and has scarcely even suggested a solution, while injection experiments and *quasi*-chemical work, such as serological investigation, have yielded no conclusive results. Failure in this direction, together with the stimulus received from successful work on general medical problems, renal disease in particular, led the bio-chemists to concentrate their attentions on the relationship between clinical and chemical changes.

Pregnancy toxæmia, glycosuria, and other conditions are admittedly little understood, and therefore treacherous in their course and difficult of prognosis. Can the clinical problems of diagnosis, treatment, and prognosis be elucidated by a chemical statement of the condition? Does chemical examination provide a guide-post pointing the clinical path

along which the patient will travel before this path is apparent by a study of her signs and symptoms ?—or can chemical investigation reveal hidden but dangerous failures of function which demand immediate relief ? These are the questions which have recently occupied the thoughts of biochemists, and the results of their work make it possible to formulate a provisional answer.

Bio-chemical methods of estimation and measurement of visceral function were applied to the kidney, and later to the liver, in toxæmia and normal pregnancy, in the hope that they might demonstrate not only a coarse co-relation with post-mortem findings, but also the commencement of incapacity in relation to clinical symptoms, and even a fine differentiation of which particular functions of the organs were chiefly affected. It was even hoped and claimed that by the time the earliest symptoms and signs were apparent there would be emphatic bio-chemical indications of the establishment and steady progess of toxæmia, whereby therapeutics would obtain guidance and prognosis could find a basis.

Observations have now accumulated in great abundance by many different workers, and each has attempted to show his results as warranting a foundation for clinical procedure. But the clinical observer especially, and some bio-chemists also, have been impressed by the great fallacies and difficulties appertaining to all visceral functional tests, difficulties not so much of a technical or chemical nature as those of interpretation and co-ordination with the obvious clinical state.

For example, there must be difficulties in measuring the functional capacity of any organ which has many widely different functions, or one whose functions are partly discharged by other tissues of the body. We know that the liver is mainly responsible for the production of urea, but this substance is also produced by other tissue cells, whereby urea will still be found in the urine up to 0·8% in women dying of acute yellow atrophy of the liver, though it is true that

even in this disease the liver is able to function to some extent.

These and other considerations are sufficient to account for the frequent discrepancies between the bio-chemical report of the condition of the liver or kidney and the clinical progress of the patient. For a time the main object of the visceral functional tests must be investigatory, and as such are of the greatest value in obtaining data and opening up new fields of thought. But rigid attempts to apply functional tests to the guidance of clinical work are largely disappointing, partly because in the incipient conditions, when chemical evidence would be of real value in providing clinical assistance, the results of functional tests are either negative, variable or of not sufficient emphasis to justify the formation of an opinion. It is in the well-defined diseases, such as severe albuminuria and eclampsia, that we may expect some uniformity of positive results, but it is precisely in these cases that clinical judgment regards itself as able to stand unsupported by the aid of confirmatory chemical data.

Apart altogether from the applicability of bio-chemical investigation to clinical work in obstetrics, the results obtained have been of the greatest value in illuminating some of the metabolic processes at work during pregnancy, and by a steady accumulation of further data it may be possible soon to piece them all together so as to produce a logical pattern of the metabolism of pregnancy.

Blood Analysis in Normal Pregnancy

The blood changes in normal pregnancy will be rendered more explicable if it is borne in mind—

1. That there must be a retention of nitrogen, carbon and other bodies sufficient to form a weight of new tissues equal to an average of $10\frac{1}{2}$ lb. in about nine months, represented by the fœtus, uterus and placenta.

2. That owing to this growth and other increased expendi-

ture of energy, there will be a correspondingly increased maternal metabolism, and therefore formation of waste products.

3. That the fœtus itself, during the later weeks, carries on a definite metabolism of its own, as shown by its dependence on a regular supply of oxygen, and therefore will add its own excretory products to those of the mother for elimination by her organs.

In addition to these abnormal conditions, the hepatic and renal functions are partially changed even in normal pregnancy, as illustrated, for example, by the lowered renal threshold for sugar, which dates from the earliest weeks.

Nitrogenous Bodies

The broad results of metabolic investigation serve to show that during the first half of pregnancy, the amount of nitrogen excreted is greater than that taken in by the food, a process which necessarily involves a disintegration of the mother's tissue protein. This will occur in spite of efforts to save this breakdown in protein by excessive protein feeding (de Wesselow & Wyatt) (1). Here we see, therefore, that altogether apart from requirements of the growth of fœtus and uterus, which might presumably be met by increased ingestion, there is an active tissue protein disintegration going on, involving a greater nitrogenous excretion. It is difficult to account for this phenomenon, but it may be explained as being caused by the requirement of some particular or specialised disintegration products of the maternal protein required for the growth of the fœtus.

During the second half of pregnancy the reverse process occurs. Less nitrogen is excreted than ingested, thus indicating a definite retention. To illustrate this, de Wesselow and Wyatt (1) quote a case observed by Hofström, in which he estimated the nitrogenous retention during the last twenty-three weeks of pregnancy. Here the daily intake of nitrogen

was 13 gm., while the retention of nitrogen amounted to 310. Of this it is calculated that only 101 gm. would be taken by the fœtal tissue development, leaving a maternal retention of 209 gm., which is far more than would be absorbed by the growing uterus and breasts. At the end of pregnancy, therefore, the mother possesses a large excess of protein above the normal, which may be necessary for the process of lactation.

Blood Urea

In the normal non-pregnant state, the amount of urea in the blood varies from 20 to 50 mg. per 100 c.c.

During the latter half of normal pregnancy, this figure is reduced to from 12 to 22 mg., an observation which has been confirmed by all workers on the subject. Higher values are occasionally found, as in Case 30 in Table I.

Not only is the absolute amount of urea reduced, but it is reduced relatively to the other non-nitrogenous bodies of the blood.

The following Table gives our (Lynch and Bourne) results of blood analysis in normal pregnancy :—

Table I

Case No.	Parity.	Gestation.	T.N.P.N.	Urea.	Uric acid.
3	—	—	31·2	—	0·88
4	—	—	28·0	—	2·2
100	1	Near term	34·0	—	3·1
101	1	Near term	30·0	—	—
102	1	36	35·4	—	2·0
103	1	38	—	—	2·0
104	1	40	35·0	—	1·4
105	1	36	34·9	—	4·6
106	1	38	34·8	—	5·5

T.N.P.N. = Total Non-protein Nitrogen.

TABLE I—*continued*

Case No.	Parity.	Gestation.	T.N.P.N.	Urea.	Uric acid.
107	1	32	34·0	—	3·2
108	1	36	28·2	—	5·3
109	Multip.	36	—	—	2·9
110	Multip.	36	23·1	—	6·5
111	Multip.	34	28·1	—	3·8
112	Multip.	32	19·0	—	2·4
113	Multip.	36	20·9	—	4·1
9	?	38	—	21·0	—
15	?	40	27·7	24·3	—
27	?	Near term	—	11·0	—
28	?	Near term	28·7	8·0	—
29	?	Near term	32·6	14·0	—
30	?	Near term	—	27·0	—

T.N.P.N. = Total Non-protein Nitrogen.

Normal values in the non-pregnant condition are as follows :—

Urea	. . . .	20–50 mg.	per 100 c.c. blood.
Total non-protein nitrogen		20–45 mg.	,, ,, ,,
Creatinin	. . .	1–1·5 mg.	,, ,, ,,
Uric acid	. . .	2–4·0 mg.	,, ,, ,,
Cholesterol	. . .	150 mg.	,, ,, ,,

It will be observed also that the blood contents of total non-protein nitrogen and uric acid range within the limits of the normal non-pregnant condition (Folin and Wu, quoted by Beaumont and Dodds) (2).

NITROGENOUS CHANGES IN ABNORMAL PREGNANCY

It is the toxæmic group of diseases of pregnancy in which we find the greatest variations from the normal of the nitrogenous condition of blood and urine. The superficial clinical

similarity between these diseases and known cases of renal and hepatic disease would lead us to expect a parallel chemical condition, but much analytical work has shown that the chemical condition differs considerably from ordinary nephritis.

The first difference is that in pregnancy toxæmia there is far less tendency for there to be a retention of nitrogenous bodies in the blood than in clinically similar conditions of nephritis. It is true that in pregnancy the normal amount of blood urea is less than in the non-pregnant, so that a smaller absolute rise may have more significance than a similar figure in non-pregnant individuals.

Even in fatal eclampsia, where toxæmia exists in its severest form, there is seldom a rise of blood urea above 75 mg. Should a much higher figure be found, it is sufficient to cast doubt on the diagnosis of true pregnancy toxæmia in favour of an exacerbation of a pre-existing nephritis induced by the pregnancy.

Uric acid tends to accumulate in the blood to a rather greater extent proportionately than urea. De Wesselow and Wyatt (1) have pointed out that, owing to the renal power of concentration from blood to urine being least for uric acid, next for urea, and greatest for creatinin, we might expect any impairment of the nitrogenous excretory functions of the kidney to be reflected first by a rise of the blood uric acid, next of urea, and lastly, of creatinin.

In order to show the application of this theory for urea and uric acid in practice, we have divided the cases investigated by us (Lynch and Bourne) into two groups :—

(*a*) Albuminuria with other symptoms, such as œdema, headache, and raised blood pressure, and
(*b*) Eclampsia.

In these tables it will be noticed that the uric acid figure attains to the high extreme of the normal limit when the urea is well within normal limits, as in cases 64 and 65, while

TABLE II

(*a*) ALBUMINURIA WITH SYMPTOMS

Series No. of case.	Blood urea.	Uric acid.	T.N.P.N.
22	22	4·5	37·3
56	57	5·8	45·0
57	61	7·8	50·0 (14/12/22)
—	31	4·2	30·5 (18/12/22)
58	37	8·0	33·3
59	39	—	45·0
64	20	4·8	35·7
65	18	5·3	35·5
66	49	6·15	37·8
68	30	5·3	38·5
69	38	5·93	45·45
73	33	—	29·8 (14/6/23)
—			(18/6/23)
—	18	3·15	27·6 Much worse
74	54	4·16	45·4 Mild case

a comparatively high urea figure is associated with a high uric acid value, as in cases 57, 66, and 58. There is, however, an exception, as in case 74, and several cases do not show any decisive evidence of the tendency to retain uric acid before urea.

From a perusal of these tables it will be noted that :—

1. The T.N.P.N., though variable, does not attain very high values, particularly in Table I., where in only five cases does it exceed 40 mg. In the eclamptic cases, the general level tends to be higher, but here also there are no extremely high values which are met with in non-pregnant cases of fatal nephritis. Compared, however, with the normal low values of pregnancy, there is some retention of nitrogen, which is liable to be greater in the severe and fatal cases.

2. The blood urea, similarly, which accounts for the chief

(*b*) Eclampsia

Series No.	Blood urea.	Uric acid.	Creatinin.	T.N.P.N.	Remarks.
24	57·0	3·8	4·7	50·0	Recovered.
25	18·0	4·4	4·1	29·8	Recovered.
51	24·0	2·5	—	35·8	Recovered.
52	22·0	2·5	—	27·0	Died.
12	70·5	—	—	65·0	Died.
18	12·0	6·6	—	37·0	(13/5/22).
—	36·0	9·3	—	53·0	(14/5/22).
19	60·0	8·2	—	62·5	Recovered.
21	38·0	6·0	4·0	28·7	Recovered.
23	72·0	9·1	—	64·5	Recovered.
67	18·0	9·7	—	45·4	Recovered.
71	40·0	17·4	—	45·8	Died.
72	52·0	7·1	—	42·6	(18/6/23).
—	43·0	6·35	—	41·0	Recovered (21/6/23).
78	90·0	11·42	—	69·0	Died.
79	48·0	13·7	—	45·4	Died.
80	44·0	5·3	—	?	One fit. Recovered.
57	61·0	7·8	—	50·0	Recovered before fits (14/12/22)
—	31·0	4·2	—	30·5	With twenty fits (18/12/22). Recovered.

part of the non-protein nitrogen, is only a little raised in albuminuria, but in fatal eclampsia there is a definite retention, with the exception of case 52, where the figure was within normal limits. It will be noticed, however, that there was no complete uniformity of findings corresponding to recovery or a fatal issue.

3. Uric acid, taking 5 mg. as the upper limit of the normal, was only occasionally retained, and on the whole showed correspondence with the value of blood urea. In the

fatal cases of eclampsia, on the other hand, there was marked increase of uric acid except in case 52, where the urea was also very low. In this case the disease was sudden in onset and rapidly fatal, possibly, therefore, allowing for little opportunity for marked changes in the blood.

4. The estimations of creatinin have been too few on which to base any conclusions, though in three cases of eclampsia it was increased by about three times the normal, relatively much more than in the case of urea or uric acid.

5. It will be observed that the urea nitrogen accounts for less than half of the T.N.P.N. in many cases, and that the difference cannot be accounted for by uric acid creatinin, ammonia, and amino-acids. This unknown moiety of nitrogen has not hitherto been fully investigated.

Condition of the Urine

The nitrogenous condition of the urine gives further evidence of the renal power of excretion. The broad results of urine examination are that, as observed in the case of the blood, nitrogenous excretion is not seriously impaired. The volume of urine (*i.e.*, the water) is reduced in many cases of toxic albuminuria, and all cases of eclampsia. This is probably primarily due to an inability of the kidney to excrete chlorides, with the result that they are retained in the body and thus prevent normal excretion of water. In one of our cases (case 19) there was no turbidity on adding nitric acid and silver nitrate to the urine, showing that chlorides must have been entirely absent. A further factor increasing the difficulty of water excretion is probably purely mechanical. Clifford White (3) has shown by microscopic examination of eclamptic kidneys with anuria that the collecting tubules were obliterated by the enormous distension and thrombosis of the intertubular capillaries. In both his cases after incision of the enlarged hard kidneys there was an immediate and copious flow of urine, and both patients recovered. A temporary suppression of urine is

usual during the period of fits in eclampsia, but this is almost, if not entirely, due to the congested state of the kidneys. When Cæsarean section was done for eclampsia opportunity for palpating the kidneys presented itself, and it was a common experience to find them enlarged and extremely hard.

The powers of nitrogenous excretion are not seriously impaired in true pregnancy toxæmia, though in pregnancy associated with pre-existing nephritis there will be all the usual features of nephritis aggravated by the extra burden of pregnancy.

The percentage of urea in the urine is seldom below 2%, and MacLean's urea concentration test will usually yield a percentage of urinary urea above 3%. Even in acute yellow atrophy of the liver the urea may be found as high as 0·8%. The ammonia of the urine is always increased in pregnancy. While the ratio of ammonia nitrogen to other nitrogen is ordinarily 3% (ammonia coefficient), it is commonly found at 5%, and in the presence of vomiting may reach as high as 10 to 20%, even when there is no toxæmia present. In toxæmia or acidosis in pregnancy this coefficient may be raised as high as 25 or 30%. But the amount of ammonia is no longer regarded as a necessary indication of the extent of the toxæmia. Ammonia is a base at the disposal of the body for the neutralisation of any excessive acid production, and, therefore, its excretion will tend to rise if there is acidosis present. On the other hand, the partition of nitrogen between urea and ammonia is influenced by so many other factors, such as food intake, the muscular work of convulsions and idiosyncrasies of the patient, that very little guidance can be taken from the ammonia coefficient. A further characteristic of the urinary nitrogen values in toxic pregnancy is their sudden change. During the course of a few hours the urea nitrogen percentage may fall from 75 to 35 with a rise in the ammonia nitrogen, but by no means corresponding with the fall of urea. Further, with cessation

of the fits the normal excretion may be re-established almost immediately. It is, therefore, common to obtain apparently conflicting results while examining one patient during the course of twenty-four hours.

The diastase content of the urine has been found to vary in nephritis and toxæmia. The normal diastase excretion is reckoned as being 10 units as measured by a standard method. In nephritis this value is reduced, and may even be zero, but in pregnancy toxæmia it is liable to be increased up to 20 or more units. But the estimation of diastase is liable to considerable error owing to the variations in the reaction of the urine. It is claimed by Mackenzie Wallis (4) to be an early prodromal change in the urine before the onset of convulsions, but many cases of eclampsia occur without any marked rise in diastase.

Hyaline and cellular and occasionally blood casts are invariably found in eclampsia, but not in ordinary toxic albuminuria. The number of the casts has little or no prognostic significance, and by the fourth day after cessation of fits they usually disappear. The urine of recovered cases of eclampsia is always examined before discharge from Queen Charlotte's Hospital, and in nearly every case casts have disappeared by the tenth day. In long-standing cases of albuminuria they may be found for longer periods after cessation of fits, but it is rare for casts to persist.

The diastase content of the urine, at first thought to be a reliable means of diagnosis between toxæmia and nephritis, is now regarded as of little value, inasmuch as there is great variation and little correspondence between the amount of diastase and the clinical condition.

The ammonia coefficient was formerly considered as definite evidence of severe toxæmia, especially in cases of hyperemesis when raised above 10%. We know now, however, that there are many factors which influence the nitrogen partition, and that a high ammonia coefficient is no indication of deficient ureogenic function, but is more closely allied to acidosis.

Carbohydrate Metabolism

The processes of carbohydrate metabolism in the body are under a complex control, and their further study serves rather to increase the difficulty of comprehension than elucidate the problem. The broad lines of carbohydrate changes in the body were laid down by Claud Bernard, and as such they still stand the test of experience ; but many further facts have since been brought to light, such as the influence of the endocrine secretions on sugar metabolism. When, however, attempts are made to piece together the facts, it is obvious that there are still some missing links in the chain of the complete story.

The basic principles seem proved and clear. All carbohydrates are broken down by digestion into monosaccharides and absorbed as such, chiefly in the form of glucose. If the accumulation of absorbed sugar in the blood rises beyond a certain percentage, namely, 0·18%, it is excreted by the kidney into the urine until the percentage concentration has fallen to 0·18%. In normal health, however, the liver is able to, and always does, abstract the glucose from the blood until the percentage falls to about 0·09%. An amount of sugar is therefore maintained in the blood between the limits of 0·09% and 0·18% by the activities of the liver and kidney. The sugar abstracted from the blood by the liver is stored therein as glycogen, and passed back again into the blood stream in the form of glucose as carbohydrate is required by the body for the purposes of oxidation and energy production. Such is the main sequence of the elementary processes. Interacting with the functions of the liver, kidney, and tissue oxidation, however, are the forces of the endocrine glands, of which the pancreas and its active principle, insulin, have recently been investigated. Briefly stated, the influence of insulin is on the tissue cells, enabling them to utilise the sugar circulating in the blood by oxidation, while the secretions of the suprarenal, pituitary and thyroid appear

to antagonise the action of insulin. Precisely how these latter bodies act is not yet clear, but it is probable that adrenalin stimulates the liver to turn out its glycogen into the blood stream as glucose, causing a hyperglycæmia and so glycosuria, while excess of pituitary secretion also causes a prolonged hyperglycæmia after ingestion of carbohydrates.

In addition to the foregoing there is also a so-called nervous factor brought into play by Bernard's "piqûre diabétique," or puncture of the floor of the fourth ventricle. This is probably really an endocrine process caused by stimulation of the sympathetic acting on the suprarenals leading to the secretion of adrenalin into the blood stream, for the effect cannot be produced if the splanchnic nerves have been previously divided. Such is the complexity of a little-known process in the normal individual. When, however, the subtle influence of pregnancy is superadded, the phenomena become still more difficult to interpret. A solid foundation of knowledge of the influence of pregnancy on the endocrine functions is the histological changes in the pituitary gland, and alterations of the basal metabolic rate. The structural changes of the pituitary, chief of which are a great increase in size and conspicuous alterations in the cellular composition, must mean either an alteration or increase in function of the gland during pregnancy. It is significant that these changes are quite advanced during the early weeks. Further, the increase in basal metabolism (*i.e.*, the rate of oxidation in the resting and starving state) which is usually noted in pregnancy, especially during its latter half, up to as much as 33% above the normal zero (Wilson and Bourne (5)), indicates also deep-seated metabolic changes going on in the body.

If, therefore, structural changes in a gland known to influence carbohydrate metabolism, and alterations in the metabolic rate, are observed in pregnancy, it is clear that visible evidence of altered carbohydrate processes will probably be found.

The scientific problem is the discovery of the cause not

only of the glandular changes, but the mode in which they influence carbohydrate changes, while the clinical problem is the detection of aberrations, the recognition of excess, the relation of such changes to the general state of the patient, and the ultimate prognosis.

The scientific or chemical part of the problem belongs chiefly to laboratory investigation, while the clinical elucidation depends upon the simple estimation of the blood and urine sugar and ketone bodies, correlated by observations on the general condition of the patient both immediate and remote.

Carbohydrates in Pregnancy

The most obvious symptom of an altered carbohydrate metabolism during pregnancy is the frequent condition of glycosuria, usually during the latter half of gestation, or, if there is no actual glycosuria, its easy provocation by carbohydrate feeding. Indirect evidence is the existence of acidosis, to which we shall refer again in a later paragraph.

The tendency to glycosuria during pregnancy has been utilised as a means of diagnosis of pregnancy (Frank and Nothmann (6)) in the earliest weeks, when clinical examination is uncertain, for the metabolic or excretory change which produces glycosuria appears almost immediately after conception has taken place; indeed, it is probable that this condition is one of the earliest biochemical changes which take place in pregnancy, but the test is said to be useless after the fifth month. Whether or not it is a reliable test is as yet unproved, but it is a fact in a very large number of pregnant women during the earliest weeks, glycosuria will appear if 50 to 100 gm. of glucose are administered.

A clinical examination of glycosuria in pregnancy has recently been published by Crook (7). He reports on 548 patients, including certain abnormalities of pregnancy, and found that 166, or 30%, had, at some time or other during

their pregnancy, sugar in the urine other than lactose. In 4% of patients the glycosuria was repeated in successive pregnancies. After a careful analysis of his cases Crook tentatively suggests that there are two groups of glycosuria of pregnancy:—

1. "A benign type which is generally noticed before the fifth month, but may also be detected very late in pregnancy, *i.e.*, after the thirty-fourth week. This may be transient or intermittent, or it may be a condition which was present before pregnancy, and will persist after it, unaccompanied by any serious symptoms."

2. "A type in which the sugar generally commences at about the twenty-first to the twenty-third week; it is often accompanied by symptoms usually associated with some toxæmia of pregnancy, which continue until the term of pregnancy, and in some cases will recur with succeeding pregnancies. It is specially associated with cases in which there has been severe early vomiting, which has often subsided later. In the later months it is also associated with œdema (not necessarily accompanied by albumin), this being a link perhaps with chloride metabolism."

Whether or not further work will confirm the different time incidences of glycosuria as marking two distinct clinical types of the condition, it is a well-known fact to clinical observers that there are, excluding true diabetes mellitus, two distinct types of glycosuria in pregnancy, one in which there are no symptoms whatever, and the other in which the patient is definitely ill, apparently toxic, and yet not showing all the signs of ordinary pregnancy toxæmia, namely, albuminuria and raised blood pressure. This pseudo-toxic condition is not at present fully understood, nor do we know anything definite of the prognosis, but it is clear that there is a type of glycosuria in pregnancy, apart from diabetes (*i.e.*, with a normal blood sugar) which is associated with symptoms of illness, in addition to the harmless condition of simple glycosuria. Other observers (8) also agree that the general

incidence of glycosuria in pregnancy reaches or exceeds 50% of all pregnant women.

Prognosis is as yet uncertain, and requires establishing by a long series of observations on the health of women who have been known to have glycosuria during pregnancy. This is a work extending over years, which can only be done by the records of general practitioners who are in touch with their patients for long periods.

Taking the three fairly well defined types it is possible to make the following tentative statements :—

1. True diabetes mellitus. This disease is rarely associated with pregnancy, as diabetics are comparatively infertile, but if it does occur the outlook is likely to be serious. Before the days of insulin the patient was in considerable jeopardy not only from an exacerbation of her disease during pregnancy, but even more during labour and the puerperium. In addition, septic lesions and indefinite febrile conditions were likely to complicate the puerperium. Since the introduction of insulin, however, the outlook is much safer. A patient recently in the writer's hands, and under the joint care of Dr. C. McMorant Wilson, passed through pregnancy, labour and the puerperium in great danger, in spite of strict dietetic treatment, but without insulin. After prolonged illness during the puerperium she recovered and again became pregnant. In the interval, insulin had been discovered, and it was possible to treat her by this principle during the second pregnancy. Not only was pregnancy passed without any deterioration of her condition, as happened on the first occasion, but Cæsarean section was performed for the purpose of sterilisation, and the puerperium passed without any untoward symptoms.

Granted, however, that insulin is able greatly to ameliorate serious effect of pregnancy on diabetes, the fact remains that pregnancy is a heavy extra burden for the diabetic woman to carry, and the risk of increased impairment must be very serious. Lublin (9) gives the mortality as high as 30%.

2. Glycosuria without symptoms.

In these cases it is found that there is no hyperglycæmia, and that sugar at once disappears from the urine on starving the patient.

It also disappears within a few days after labour. Should the woman become pregnant again it may return, but the majority of women appear to be free.

3. Glycosuria with pseudo-toxæmia.

When discussing this condition Crook is impressed with the association of other symptoms, *e.g.*, vomiting, hydramnios, œdema, etc., and suggests that it may be a precursor of true diabetes in later years. In support of this suggestion he quotes Barrenger and Roper (10), who state that an examination of insurance statistics shows that after five years 20% of their supposed renal diabetes had developed true diabetes, 25% were suspicious, while 55% remained free.

This collateral observation lends colour to the view that the glycosuria of pregnancy, even without hyperglycæmia, may be the precursor of ultimate diabetes.

Chemical Pathology.—In normal health in non-pregnant individuals no glucose passes through the kidney from the blood to the urine until the percentage of sugar in the blood rises to 0·18%. This figure is regarded as the normal " renal threshold " for sugar, for above this point glucose will appear in the urine.

In early pregnancy, however, the renal threshold is frequently lowered until sugar can be excreted by the kidney even when the blood sugar does not rise above 0·12% or thereabouts. As stated above, this alteration in the renal threshold appears almost immediately after fertilisation, but tends to return to the normal about the fifth month. Meanwhile, the level of the sugar in the blood (0·09 to 0·11%) remains normal, and follows the ordinary variations after meals, *i.e.*, there is no hyperglycæmia even when glycosuria is present. There will, therefore, be immediate disappearance of glycosuria by dieting, or provocation thereof by adminis-

tration of a carbohydrate meal. This condition is generally described as " renal diabetes," indicating an alteration of the renal threshold to differentiate it from true diabetes, in which there is hyperglycæmia. The cause of the modification of renal activity is not known, but it is probably related to the activity of the ductless glands whose secretions stimulate the kidney to excrete glucose, *e.g.*, the pituitary.

Mackenzie Wallis (4) has recently considered the glycosuria of pregnancy by the application of glucose tolerance tests and simple estimations of the blood and urine sugar. The result of his work has led him to divide the condition into four groups, but these groups are not very sharply defined by him, nor described with sufficient detail to enable clinical recognition. The chief part of the paper is devoted to showing that there is a pituitary form of glycosuria in pregnancy due to a normal hyperpituitarism, comparable to the glycosuria found in dystrophia adiposo-genitalis or acromegaly. As we know that there is considerable hypertrophy of the pituitary in pregnancy, it is possible that the glycosuria described by Wallis may be its chemical accompaniment. Cases of glycosuria with gross hyperglycæmia (*i.e.*, above 0·18%) come under the head of true diabetes mellitus, and require most careful consideration and treatment. The disease is rare in pregnancy and has always been regarded as a most serious complication, with a mortality of about 30%.

Urobilin and Urobilinogen in the Urine

Berkeley, Dodds and Walker (11) have recently brought forward evidence of the importance of these bodies in the urine as indications of hepatic damage during toxæmia of pregnancy.

It may be remembered that the bile pigments (bilirubin and biliverdin) excreted into the intestine with the bile are there broken up into urobilinogen, urobilin and stercobilin and other substances. Of these, urobilinogen and urobilin

are re-absorbed into the blood stream, picked out by the liver cells and re-excreted as bile pigments. An extremely small quantity of urobilin finds its way into the urine, but it is of negligible amount. In disease of the liver cells by toxic or infective processes, there is partial failure to abstract all the urobilin from the blood, where it accumulates. It is then excreted by the kidneys and is easily recognised in the urine. Berkeley, Dodds and Walker were led by their experience of examination of salvarsan intoxication to apply the same methods to determine evidence of hepatic damage in toxæmia, and they claim that the presence of urobilin and urobilinogen in the urine is the earliest and surest guide we have as yet of the presence of hepatic impairment. These observers found that acetone was present (Rothera's test) in the urine of more than half of pregnant women, and of nearly all toxic pregnancy.

In the investigation of urobilin in the urine they found the following results :—

I. Normal Pregnancy

No. of Cases.	Blood	Urine.		
	Bile.	Urobilin.	Urobilinogen.	Acetone.
10	All negative.	All negative.	All negative.	All positive.

II. Albuminuria without Symptoms

10	All negative.	All negative.	All negative.	7 positive. 3 negative.

III. Albuminuria with Symptoms

17	(Two examined twice.) All negative.	All negative.	All negative.	13 positive. 6 negative.

IV. Eclampsia

7	All positive.	All positive.	All positive.	All positive.

It seems clear from this report that if urobilinuria is a test of functional impairment of the liver cells, such impairment is a feature only of eclampsia, and is either a secondary

result of eclampsia or is produced by some toxin which at the same time provokes fits. It is pointed out in their paper that the pigment tests of the urine have no correspondence with the blood urea values, which vary within wide limits.

Value of Visceral Function Tests in Pregnancy

1. **Kidney.**—A very great deal of work has been done in trying to establish evidence of impaired function of the kidney in normal and toxic pregnancy, and very many tests have been suggested as being reliable.

Attention has been devoted to the various urinary bodies in turn and their retention in the blood and output in the urine has been estimated.

We have already described some of these chemical phenomena ; it will be instructive to sum up the clinical value of chemical analyses.

(*a*) *Nitrogenous Bodies.*—de Wesselow has stated that a blood urea of over 40 mg. of urea indicates sufficient evidence of impaired power of excreting urea to warrant termination of pregnancy. More recent work, however, has shown that the amount of urea in the blood is no true clinical guide unless it reaches high proportions, such as over 75 mg., when it might indicate a severe condition of true nephritis. Even then it is unwise to rely on this factor alone, it must be taken in conjunction with other signs and symptoms, and should only rank as a confirmatory finding. We have already noted how sudden and great are the variations of urea in the blood and urine, and very high amounts may be reduced to normal within a few hours. The urea of the urine is of little value as a test of impairment of renal or hepatic tissue or as an indication for induction of labour.

But the capacity of the kidney to concentrate urea from the blood to the urine can be measured, and is of real value as a function test.

The urea concentration test of MacLean is a simple and useful means of testing the power of the kidney to concentrate

urea from the blood to the urine. Fifteen grammes of urea are given in 100 c.c. of water before breakfast. The patient empties the bladder before taking the urea, and again after one, two and three hours. The three samples are measured and the percentage of urea determined by the hypobromite method. Usually 100 c.c. will be passed at the end of the first hour, and about 40 to 60 c.c. at the end of the second and third hours.

It is after the initial diuresis has passed that the kidney has to exert its powers of urea concentration, and a figure of 3% and over is usually attained by the normal kidney during the second and third hours. MacLean states that anything less than 2% indicates an impaired power of urea excretion and tendency to nitrogenous retention (azotæmia). In the worst cases the percentage may not rise above 1%. In ordinary varieties of nephritis MacLean has found this test one of the simplest and most efficient methods of testing the renal nitrogenous function, but in toxic pregnancy it is only of value as an indication of the kidney state at the time of testing, and, owing to the rapid variation of the renal condition in toxæmia, it is of little value as an indication for treatment or prognosis.

Uric acid and, still more, creatinin retention are perhaps of more value as indications, but the methods of accurate estimation of these bodies in the blood are too laborious for ordinary clinical work.

(*b*) *Water and Salts.*—The estimation of the power of excretion of water is simply done. If 500 c.c. of water are drunk, the kidney should excrete from 400 to 500 c.c. of urine in each half hour, but in toxæmia with œdema, there will be a reduced output. Clinical experience, however, shows that the extent of water excretion or œdema has no bearing on the severity of the toxæmia; in fact, at Queen Charlotte's Hospital we have found that out of about ninety cases of eclampsia the mortality was twice as great when no œdema was present. It is true that a marked reduction of the amount of urine is

unfavourable in toxæmia, and that with clinical improvement under treatment the amount increases. Further, in the worst cases of eclampsia the urine may be entirely suppressed for some hours or even days, and reappearance of excretion may be a valuable sign of approaching recovery. But the fact remains that the milder degrees of diminished excretion seen in albuminuria have little prognostic importance, are readily observed clinically and quickly disappear with treatment in bed.

For a complete account of renal function tests I refer the reader to the companion volume "Recent Advances in Medicine," by Beaumont and Dodds.

Clinical Application of Renal Function Tests in Pregnancy

Many attempts have been made to apply the findings of biochemistry to clinical work as a basis for treatment and prognosis. On the whole it cannot be denied that the disparity between the chemical and clinical conditions is often so great and variable that the reports of chemical analyses become of increasingly less use as the observer gains in clinical experience. In spite of the comparatively unknown and sometimes treacherous course of a case of pregnancy toxæmia, a growing clinical experience is more safely to be relied upon than the multiple reports of the most accurate chemical worker. The writer sets forth this view after having worked closely with a biochemist (Dr. G. Roche Lynch) on upwards of 100 cases of toxæmia in all its forms at Queen Charlotte's Hospital, in a conscientious endeavour to find in chemistry a fingerpost for clinical guidance.

Biochemistry has very greatly increased our knowledge of the metabolic processes of normal pregnancy and toxæmia, and as a means of investigation it is of the utmost value, but in the present state of our knowledge the fact remains that if the chemical findings conflict with the clinical signs it is wiser to act upon the indications of the latter. But chemical

data and functional tests have their chief value as a means of diagnosis of true pregnancy toxæmia from a pre-existing nephritis. A correct diagnosis here is of importance in view of the serious effects of continued pregnancy on the mother, and the grave chance of fœtal death in spite of rigorous medical treatment, while true pregnancy toxæmia offers much less risk to the fœtus and frequently abates under treatment. In addition, the clinical signs may be ambiguous and not sufficiently indicative of either condition to warrant what perhaps may be the serious procedure of terminating pregnancy before the child can be expected to survive.

We may best illustrate the chemical diagnosis by setting out the details in tabular form :—

	Pregnancy Toxæmia.	Chronic Nephritis.
Blood urea.	Usually under 50 mg.	May be 70 mg. or more.
Urea concentration test.	Usually above 2%	May be below 2%.
Diastase in urine.	Very variable.	Usually below 10 units.
Urinary albumin-globulin ratio of urinary protein (Wallis).	2 to 1	6 to 1.

To sum up, the writer finds that in a true case of pregnancy toxæmia, the clinical signs form a sufficient and more reliable indication of treatment and prognosis, but that in cases of doubtful diagnosis, where it is uncertain whether it is a case of toxæmia or of pre-existing nephritis, chemical investigation may give assistance, and if these data point to serious impairment of renal function induction of labour is carried out at once.

Tests of Liver Function and their Clinical Application

Greater difficulty has been experienced in measuring the efficiency of the liver than even the kidneys, chiefly on

account of its multiplicity of functions and partly because some of these functions can be discharged by other tissues.

There are only three tests which at present are of any reliable value. Many others have been attempted, but they are not proved sufficiently, or are too difficult for routine use.

The damage sustained by the liver in eclampsia and acute yellow atrophy in pregnancy is one of the leading pathological features of the disease and has suggested that if a true indication could be obtained by chemical means before the clinical evidence was obvious we might possess a real indication of the necessity or otherwise for the induction of labour. But at present it must be confessed that liver tests have not been of much practical assistance.

1. **The Lævulose Test.**—This test is a measurement of the power of the liver to store lævulose. In normal health it is possible to give an individual 50 to 75 gm. of lævulose without producing any alteration in the level of blood sugar, but if the glycogen storing power of the liver is impaired, the level of the blood sugar will rise.

The writer, in conjunction with Dr. G. R. Lynch, has applied this test to a number of cases of normal and toxæmia pregnancy, including eclampsia. Very little positive evidence was obtained except in one or two eclamptics, where the blood sugar rose to a level which was interpreted as indicating hepatic impairment.

2. **Tests of Pigmentary Functions.**—Reference has already been made to this test, and the conclusions to be drawn therefrom (see p. 79).

3. **The Phenol-Tetrachlor-Phthalein Test.**—This is the only test based upon the excretory functions of the liver. If phenol-tetrachlor-phthalein is injected intravenously it is excreted in the bile. Its presence can be measured in the blood after injection, and any delay in its disappearance from the blood stream by excretion with the bile is regarded as evidence of impairment of the excretory powers of the liver.

Little work has yet been done with this test, but de Wesselow and Wyatt state that in a few cases of albuminuria some delay in excretion of the pigment has been observed, suggesting the earliest evidence of hepatic insufficiency.

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CHAPTER V

REMARKS ON ANTE-PARTUM HÆMORRHAGE

Our knowledge of the pathology and our experiences of the treatment of " accidental hæmorrhage " have made considerable advance during recent years under the investigation of many observers in both Europe and America. In 1885, Winter first drew attention to the presence of albuminuria in patients suffering from accidental hæmorrhage, since when we have gradually come to recognise that the hæmorrhage is often merely a symptom or result of a deep seated systematic disease producing other effects in different parts of the body. In 1921, Gordon Ley (1) published a review of previous work, and, by the inclusion of his own work on fifty cases, added further evidence of the toxæmic nature of accidental hæmorrhage.

In spite, however, of the large percentage of incidence of albuminuria, it is true that there is a definite number of cases which cannot be explained on the toxæmic theory, inasmuch as they show no signs or symptoms even when examined completely post-mortem. This theory, therefore, is not all sufficient, and as yet we do not possess any well-based theory which will explain all cases.

Pathology

Many conditions have been stated as being possible causes of accidental hæmorrhage, such as syphilis, endometritis, mental shocks, direct trauma to the abdominal wall, but none of these causes can be proved to play any large part in any given series of cases. Albuminuria, however, is found

in a large proportion of the cases (in 84% of Ley's) either with or without other evidence of toxæmia such as œdema, high blood pressure, vomiting or even eclampsia (34% of Ley's series), and it is therefore justifiable to regard accidental hæmorrhage as being frequently an effect of the toxæmic process on the muscle and vessels of the uterine wall. Naked-eye examination of the uterus often finds small linear peritoneal tears exuding blood, while section of the muscle shows hæmorrhage of varying extent scattered throughout the fundus.

In some fatal cases the liver is greatly enlarged and fatty, and the kidneys show much parenchymatous degeneration. Microscopical examination of the uterine muscle reveals a succession of degenerative changes, extending to actual necrosis of muscle bundles. Firstly, there is a peri-vascular œdema and leukocytic infiltration ; this is followed by cloudy swelling of the muscle fibres, loss of staining power, and fragmentation of the nuclei—in short, complete necrosis of muscle bundles. Either associated with or apart from necrosed areas are seen widespread hæmorrhages, separating contiguous muscle fasciculi and occasionally approaching the decidual surface or the placental site. The necrosis of the muscle can be proved to be independent of hæmorrhage and not caused by it, by the occurrence of each condition separately. The chief changes in the vessels are swelling of the endothelium, which may be sufficient to cause it to project into the lumen of the vessel, and hæmorrhages in the actual wall of the vessel. Whitridge Williams believes the vessels to show the effects of a circulating toxin which causes endotheliolysis and extravasation of blood through the damaged vessel wall. Should this blood percolate through the uterine muscle towards the placental site it will ultimately escape beneath the placenta as retro-placental hæmorrhage, and tend to strip up the placental attachment according to the pressure of the escaping blood. It is possible by this means for the whole of the placenta to be detached from the uterus

by an incarcerated hæmorrhage, or, if the tone of the uterus has not been impaired too much by the necrotic process, the blood may be forced down between the membranes and uterine wall until it escapes per vaginam.

It is clear, therefore, that in the majority of cases of accidental hæmorrhage, mechanical causes play no part. It is emphatically not due to an " accident " in the traumatic sense, and every advance in our knowledge obtained by research into this condition still further confirms our ideas of the part played by maternal disease. Some cases of accidental hæmorrhage, or, better termed, utero-placental hæmorrhage, are as much manifestations of toxæmia as eclampsia.

Whitridge Williams (2) has recently published work which warns against a too ready acceptance of the toxæmic theory for all cases. He suggests that while previous writers such as Ley have reported a high percentage of their cases of accidental hæmorrhage with albuminuria, yet many of these cases have so small an amount of albumin, and no other sign or symptoms of toxæmia, that the real incidence of undoubted toxæmia cannot be as high as the percentage of albuminuria would lead us to think. Analysing his own cases he finds that at least 40% had no albuminuria or suffered from any of the usual signs of toxæmia. On the other hand, the most serious cases of hæmorrhage (26%) had marked albuminuria. Two fatal cases on whom complete post-mortem examinations were performed showed no anatomical sign whatever of toxæmia. In the light of evidence such as this, therefore, it is clear that the toxæmic theory cannot go the whole way in explanation of the cause of premature separation of the normally situated placenta. Further, it is not yet certain that traces of albumin may not be secondary to the placental separation and hæmorrhage, and not an indication of a primary toxæmia. Miller (3) has shown that albuminuria occurs in a considerable proportion of cases of placenta prævia (45%) where placental separation has occurred by

purely mechanical means. It is possible, as suggested by Young, that the autolytic processes arising in the dying placenta, which is separated from the maternal circulation, may set free products which, when absorbed, cause albuminuria. If this explanation be true, we have mild degrees of albuminuria as secondary manifestations of placental separation, and not indicative of a primary toxæmia.

We are still as far from knowing a true invariable cause of accidental hæmorrhage as ever we were, though we have progressed in the direction of finding associated conditions. In considering a possible cause, we must bear in mind that many cases of placental separation show no signs or symptoms of toxæmia whatever, and occasionally this may be true of the worst cases of concealed hæmorrhage; but, on the other hand, the worst cases usually do show not only albuminuria, but other signs of toxæmia, particularly great œdema.

Treatment by Vaginal Plugging

It is Hastings Tweedy who has chiefly drawn attention to the value of vaginal plugging for ante-partum hæmorrhage with insistence on the great importance of carrying out the operation efficiently. The method in use at Queen Charlotte's Hospital differs slightly from his description, but in essentials it is very similar.

The patient is anæsthetised and placed in the lithotomy position. The skin and vagina are then thoroughly disinfected by iodine or "blue paint" (methyl violet 1/2%, brilliant green 1/2%), or flavine; a speculum is introduced, and the bladder emptied by catheter, the cervix identified, and the membranes ruptured. The rupture of the membranes and allowing of the liquor to escape by pushing up the vertex are essential points in the technique of vaginal plugging. If the fluid drains away, labour pains will begin sooner and the vertex can be better pressed down on the pack by the contracting uterus. In cases of central placenta

prævia it may be necessary either to bore through it with a pair of sinus forceps or Spencer-Wells forceps, or pass the finger round the edge and rupture the membranes at the nearest point to the os. The danger of these procedures is hæmorrhage, but it is seldom long continued. It is minimised by using a thin instrument like a pair of sinus forceps to pierce the placenta with as little disturbance to its attachment as possible. Occasionally the bleeding may be so severe as to preclude any further attempts at finding the liquor amnii, and plugging must be carried out immediately. It is, however, generally unsatisfactory if the membranes have not been ruptured.

When the liquor amnii has escaped the vagina is then packed as tightly as possible with gauze. If the patient is a multipara, the left hand is placed in the vagina and gauze soaked in flavine solution 1 in 1,000 is fed into this hand from a 6-in. roll from the right hand. The left hand carefully packs the gauze systematically all round the cervix, filling up the vaginal vault. It is necessary to press the gauze firmly into the vagina as its canal is being distended by the left hand. At least a whole 6-in. roll should be accommodated by the vaginal vault, after which the lower part of the canal is similarly packed with a second roll. Occasionally part of a third roll can be introduced. The patient is then turned on to her back and a tight binder is applied to press the presenting part well down into the pelvis on to the vaginal plug. The operation is completed by fixing a T-bandage to provide support for the plug. A catheter must be passed in six hours as the patient will be unable to pass urine.

Effects of Plugging

If the membranes have been ruptured the presence of the plug will probably excite the onset of pains within a few hours. The time is variable, and may be delayed for twenty-four hours, but so long a delay is not common unless the

patient is blanched and shocked at the time of the plugging. Under these circumstances the delay is beneficial, inasmuch as it offers the patient an opportunity for recuperation. Delay will also be prolonged if the membranes have not been ruptured.

If the onset of pains is delayed for twenty-four hours, it is necessary to remove the packing and replug as before, lest infection should occur. When removing a plug after twenty-four hours, it is not uncommon to find an offensive odour, however antiseptic has been the technique, but such an infection does not appear to be of much importance, judging by the results. It is true that infection is a danger of plugging the vagina, but I shall refer to this subject again later.

The usual result of plugging is an onset of labour within twelve hours which progresses continuously and rapidly. Perhaps the most striking clinical phenomenon is the rapidity of the dilatation of the os, even when the pains do not appear to be unusually strong. It is not uncommon to find the plugging bulging from the vulva long before any descent of the head is expected. When such bulging is seen the gauze should be gradually pulled out as it is pressed down from above, and when, finally, the last piece of gauze is removed, the head can be seen on the perinæum.

An invariable and essential effect of the plug is the arrest of all further hæmorrhage. When it has been properly carried out against a vertex presentation, further bleeding never occurs. It is often a matter of surprise that, even with central placenta prævia, the gauze is not stained throughout by blood. The certainty of the arrest of bleeding renders this method of particular value when treating a woman already blanched.

Advantages of Vaginal Plugging

Apart from the arrest of hæmorrhage, there are other advantages derived from this method. The first is that it

requires no *intra-uterine* manipulation, such as version, or the introduction of a de Ribes' bag, and therefore not the danger of exciting a further attack of bleeding such as often happens when these procedures are being carried out. In many cases rupture of the membranes, the necessary antecedent to plugging, causes no bleeding, and the actual insertion of the gauze will not only not excite bleeding, but stop any that may be going on.

Secondly, there is not the same danger of laceration of the cervix and lower segment of the uterus that is sometimes seen after pulling down a leg or expulsion of a de Ribes' bag. The vascular condition of the lower segment when carrying the placenta renders it more liable to tear, but this danger is rather prevented by the support given to the cervix by the presence of the plug, than increased as by some other forms of treatment. Thirdly, the operation of plugging requires very little apparatus, as, for example, a de Ribes' bag, and little manipulative skill such as is necessary, for example, to perform some cases of bi-polar version. It can be done at any time, either before or after labour has begun. The size of the os is immaterial and also the position of the placenta. Lastly, the chance for the child is as good as, if not better than, that of any other vaginal method of delivery.

Limitations and Disadvantages

I have already emphasised the necessity for rupture of the membranes before inserting the plug. Suffice it to say here that the efficiency of the method is limited considerably if the membranes remain intact.

The presentation should be a vertex. It is possible to plug effectively against a breech, but there is not the same degree of compression possible against the soft breech, and on theoretical grounds it could not be expected to be so efficient. Moreover, a better and frequently easier treatment when a breech presents is to bring the leg down. When the os is

small, however, this is very difficult, and cannot be done unless the os will admit two fingers ; therefore, in a few cases of breech presentation with a closed os and severe blanching when as little must be done as possible, it may be well to plug the vagina temporarily to arrest further bleeding, giving time for the cervix to dilate sufficiently to bring the leg down. Many obstetricians, however, would prefer to treat all breech cases by bringing a leg down if a vaginal method were being employed.

Undoubtedly the most serious disadvantage of plugging is infection. However carefully the plug is impregnated with antiseptic and inserted, it is liable to become offensive and therefore harbour infection if left *in situ* for more than twenty-four hours. The best antiseptic is probably flavine, 1 in 1,000. Lysol is apt to cause much soreness of the vagina, and iodine will certainly produce ulceration. Gauze (cotton) has a considerable capacity for the absorption and fixation of flavine dye, and, therefore, the plug should be thoroughly soaked in the solution. The liability of infection must be guarded against by removing the plug after not more than twenty-four hours, and, if necessary, repacking after douching the vagina. A second operation with anæsthesia is certainly a disadvantage, but it is less serious than running the risk of infection. The results of plugging are seen at their best when pains begin soon after its introduction. Unlike treatment by bringing down a leg, it is possible for pains to be delayed for more than twenty-four hours, as the vaginal pack does not appear to stimulate the onset of pains so surely as bringing down the leg. This delay usually occurs if the liquor amnii has not been allowed to escape ; in fact, there may be no tendency for the pains to begin, but if the liquor has escaped, great delay is rarely seen.

Finally, I must add that the difficulty of efficient packing is a real disadvantage of the method. Unless the process has been watched, it is unlikely that it will be done sufficiently firmly to be of any value in arresting hæmorrhage. It is also

impossible for an unassisted midwife to carry out the operation because an anæsthetic is essential.

Mode of Action

Tweedy maintains that the plug actually compresses the uterine arteries where they run in the base of the broad ligament, for he finds the method of great value in accidental hæmorrhage, where it is obviously impossible for it to compress the bleeding placental site.

In placenta prævia it is probable that it exerts counter-pressure on the vertex, held down from above by the tight binder, by which the placental site around the os is controlled. It is certain that when pains are present and hæmorrhage is likely to occur, the vertex is pressed down upon the plug at the critical time.

Results

The following are the results obtained by plugging the vagina at Queen Charlotte's Hospital between 1916 and 1922 :—

Placenta Prævia

No. of cases.	Variety.	Mother.		Child.		
		Recovered.	Died.	Good.	Stillborn.	Died.
8	Central .	6	2	0	7	1
14	Marginal .	14	0	1	7	5
17	Lateral .	15	2	6	9	4
2	Unstated .	—	—	—	—	—

In this table one case of central placenta prævia admitted in a moribund condition has been excluded.

There is, then, a total mortality of 9·7% of forty-one cases treated by plugging the vagina.

Accidental Hæmorrhage

During the last eleven years, at Queen Charlotte's Hospital, twelve cases of the severer forms of accidental hæmorrhage have been treated by vaginal plugging, with or without rupture of the membranes. Of the twelve patients, one died, a mortality of 8·3%. The total mortality at the hospital during this period was five deaths, of which one was treated by vaginal plugging, one by Cæsarean section, one by rupture of the membranes and a binder, while two patients died immediately after spontaneous delivery from post-partum hæmorrhage. It is scarcely possible to give an intelligible idea of the total mortality of accidental hæmorrhage by a consultation of the records, owing to the varying degrees of severity. There is no mortality of the mild cases, which form the great bulk of all cases, while the few rare cases of severe concealed hæmorrhage yield a high death rate. For these patients it seems certain that the least possible vaginal manipulation should be done, and that plugging is the safest procedure.

Clinical Features of Accidental Hæmorrhage

The cases may be classified on a clinical basis into (*a*) external, (*b*) internal (concealed), and (*c*) combined internal and external hæmorrhage.

(a) **External Hæmorrhage.**—A large number of cases come under this category complaining of one slight loss with no other symptoms. The hæmorrhage differs from that of placenta prævia inasmuch as the bleeding tends not to be repeated, and any one attack usually lasts longer, passing finally into a brown discharge. Examination reveals no abnormal feature, but the most important clinical fact to observe, from the diagnostic point of view, is that the fœtal head is engaged, or can be pushed well down into the pelvis.

A placenta prævia will maintain the head high out of the pelvis or even produce a breech presentation, except the mild degrees of lateral placenta prævia, which are not sufficiently low down to exert any influence on the position of the head. The position of the head in relation to the pelvic brim is therefore of considerable importance in forming a diagnosis. Albuminuria is usually not found in these mild external cases, but Ley states that in about half the cases the fœtal heart cannot be heard. Occasionally a woman may have a severe external hæmorrhage without any blood concealed internally, but these cases are rare from causes other than placenta prævia.

Treatment.—It is usually sufficient to confine the patient to bed with a mixture containing bromide and opium. In addition, she should be treated as a mild case of toxæmia. The diet should be cut down, fruit and sugar freely given, together with free drinks of bland non-acid fluids. The bowels should be moved by enemata, and strong purges should be avoided. Under this *régime* for a week almost all the mild cases will progress through pregnancy to term, when normal labour will follow. If bleeding is severe or repeated, or definite signs of toxæmia are present, which do not abate under treatment, it is safer to induce labour by rupture of the membranes and a tight binder. Plugging of the vagina is carried out if severe hæmorrhage persists after labour pains have started.

As a general rule hæmorrhage will cease as soon as labour has well started; the child will be born rapidly, followed almost at once by the placenta and a variable amount of retro-placental clot. A number of the children are born dead, due to separation of the placenta.

(b) **Internal (Concealed) Hæmorrhage.**—There are many cases of retained utero-placental hæmorrhage which cause few symptoms, and are not clinically demonstrable. The amount of blood is small, and does no more than form a small retro-placental hæmatoma. Though insufficient in amount

to produce any disturbance of the mother, it may cause the death of the child by separating more of the placenta than can support its life. Chronic nephritis is a not uncommon complication.

The clinical cases of internal (concealed) hæmorrhage are amongst the most formidable conditions with which the obstetrician has to deal. The worst cases of toxæmic hæmorrhage are concealed cases, owing to the coexisting, or rather causal, necrosis and paralysis of the uterine wall. The blood does not escape, because the uterus, having no contractile power, passively dilates to accommodate it. If the uterine muscle were capable of contracting, we should expect the blood to be forced down from the placental site beneath the membranes to the os, where it would escape, and this is precisely what does happen if and when the uterine muscle recovers sufficiently to exert its contracting power. Former explanations of why the blood does not escape, such as the closed os, or adhesion of the membranes to the uterine wall, fail before Ley's demonstration of the paralytic condition of the uterus resulting from its partial necrosis. When, with partial recovery, the uterus begins to regain its tone, blood is forced downwards, and appears at the vulva as external hæmorrhage.

The most characteristic symptom is the sudden onset of very severe pain in the abdomen. The shock produced by the pain is obvious from the pallor, weak and rapid pulse, subnormal temperature and clammy skin. Vomiting is often present. There is considerable anæmia, due to the loss of a large quantity of blood into the uterine cavity, but it is probable that much of the apparent blanching is due to shock. On examination of the abdomen the uterus is frequently, but not always, felt as a hard mass, quite unlike the normal uterus at term. It may be larger than might be expected from the maturity of the pregnancy. No fœtal parts can be recognised, nor the heart heard. There is usually great tenderness of the uterus, but an absence of tenderness

of the rest of the abdomen, such as the flanks and epigastrium. This is a useful differential sign in helping to distinguish concealed accidental hæmorrhage from sudden general peritonitis due to perforative lesions, where the shock and blanching may be almost if not quite as great, but the maximum tenderness and rigidity are found away from the uterus, *i.e.*, in the flanks and epigastrium. By the vagina the os is found closed as a rule, but if open, the membranes can be felt to be continuously tense. The urine contains albumin, and there will probably be much œdema.

Treatment.—It is important to remember that the severe symptoms which are observed on first seeing the patient, due to the initial shock caused by the first large intra-uterine hæmorrhage, are temporary, and tend to show spontaneous recovery if hæmorrhage ceases and no manipulative interference is offered at this stage. The essential requirements during the period of shock are rest, warmth, and morphia. No obstetric treatment should be applied, as of necessity it must take the form of local interference which will increase shock and have little or no effect on further bleeding.

As the shock passes there will be symptomatic improvement, but the important point to which all attention is directed is the recovery of the uterine paralysis as shown by the onset of contractions and the escape of blood externally. At first this appears as blood-stained serum, resembling liquor amnii, but later pure blood escapes. The recovery of the uterus is also a critical point in the prognosis, because, apart from its indication of the general recovery, it means that the danger of further bleeding is considerably diminished. When, therefore, contractions appear, it is safe to apply local treatment both to assist in the dilatation and still further lessen the risk of another attack of bleeding. It is safe now to rupture the membranes. This measure will reduce the intra-uterine tension and so assist the strength of the uterine contractions, but will not predispose to bleeding as it would have done before pains began.

The vagina should then be plugged and a tight abdominal binder and T-bandage applied.

The gravest cases are those in which the initial hæmorrhage or the uterine necrosis have been so great as to produce a permanent condition of shock from which the patient does not recover. Close observation of the general appearance and pulse rate and size of the uterus reveals the existence of continued bleeding into the uterus. In spite of the great risk of abdominal operation under these circumstances, it is the only alternative. Cæsarean section must be done as quickly as possible, taking every care to promote the contraction of the uterus before closing the abdomen. The uterus should not be removed unless absolutely necessary, on account of the much greater mortality which follows the extended operation.

Combined Internal and External Hæmorrhage.—This is the commonest variety of accidental hæmorrhage. It is the condition of either slight internal hæmorrhage which escapes as quickly as it is shed, or else of recovery from several internal hæmorrhages. Many of the cases are comparatively mild, but some may be deeply blanched.

Treatment should be carried out on the lines indicated above—rupture of the membranes, vaginal plugging, and an abdominal binder.

Treatment of Placenta Prævia

There are few more debated subjects in obstetrics than the best treatment of placenta prævia. One of the commonest forms of publication on this subject is a statistical review of the results of various methods of treatment in different Continental and American clinics. In many ways this is an unsatisfactory form of advocacy, on account of the unreliability of the statistical method in general, but particularly in such a disease as placenta prævia, where there are almost an infinite variety of conditions to be borne in mind. At best,

statistical papers give general ideas of what methods are being practised, and any outstanding differences in results following any one method are worth noting, but they cannot be of much value in assisting a judgment on very many individual cases. Some years ago controversy was centred upon the relative merits of treatment by bi-polar version or de Ribes' bag, but during recent years the discussion has included Cæsarean section, firstly as an alternative to all vaginal methods, and still more recently as a mode of treatment for certain well-defined types of cases.

It is realised that Cæsarean section has its own special dangers for placenta prævia, and that there are many mild conditions for which the operation is totally unnecessary. In another part of this work I consider fully the place of Cæsarean section in the treatment of placenta prævia. See p. 130.

Perhaps the first point to bear in mind is that lateral cases, *i.e.*, those in which the placenta cannot be felt when the os admits two fingers, are usually over-treated. Too much manipulative interference, or even Cæsarean section, is carried out for a case which will progress perfectly well without further bleeding if nothing more is done than simple rupture of the membranes. It is true that lateral cases may cause very serious, even fatal bleeding if treatment is delayed, but if it is carried out at an early stage, for instance after the first unmistakable hæmorrhage, the prognosis for both mother and child is very good. For purposes of forming a clinical judgment of the proper treatment it is best to classify the position of the placenta on the old lines, central or marginal, or lateral. If the placenta can be felt with a "two-finger os," the hæmorrhage will certainly be very serious unless an effective means of arrest be carried out; but if the placenta cannot be felt, then only simple methods will be required. As very many cases are those in which the placenta cannot be felt (*e.g.*, at Queen Charlotte's Hospital in 1920 there were nineteen central cases, twenty-one lateral, and eight marginal),

it is obviously important to realise the value and success of rupture of the membranes and a tight binder. At the same time it must be admitted that this little operation, which is spoken of so lightly in some books, may be a very difficult matter to carry out, unless the patient is in the lithotomy position with a good light over the operator's shoulder. If the os is undilated it will be necessary to insert a speculum, grasp the cervix by volsellum forceps, and pass a pair of toothed forceps through the os to tear through the membranes. If the dilatation is more than a finger this should not be difficult, but if the os will not admit a finger it may be necessary to dilate it by Hegar's dilators before the membranes can be found. Not infrequently it will be found that the membranes will retreat before the toothed forceps, thus lifting up and separating more of the placenta, with further escape of blood. This can to some extent be avoided by firm pressure on the fœtus from above. It is, of course, obvious that this method of treatment should only be adopted if there is a vertex or breech presentation.

Of seventeen cases treated at Queen Charlotte's Hospital by rupture of the membranes with or without an abdominal binder there was no mortality of the mother, and of twenty-four cases (marginal fourteen, lateral ten) of spontaneous normal delivery there were two deaths. The fœtal death rate for both marginal and lateral cases treated by rupture of the membranes was 26%, which includes all children irrespective of their maturity. On this experience, therefore, it is clear that the lateral cases at least, or those in which the placenta cannot be felt, require no further treatment than rupture of the membranes and an abdominal binder.

Those patients in whom the placenta can be felt either at the margin or covering the os require more than simple rupture of the membranes, though it is true that some marginal cases have been treated at Queen Charlotte's Hospital by nothing more than rupture of the membranes (number of cases seven), with no mortality ; yet a sufficient

number have not been treated upon which to base an opinion. If Cæsarean section is not the method of choice, one or other vaginal method, either version or metreurysis or plugging, must be adopted. The statistical results of some recent writers are as follows :

Schweitzer (4) states that out of 333 cases of placenta prævia twenty-two " partial " (? lateral) cases were treated by rupture of membranes without any mortality, an experience in agreement with our own at Queen Charlotte's Hospital.

Of the remainder about 40% were treated by a hydrostatic bag, the choice of the method depending upon the relative conditions of both mother and child. For example, if the mother was in good condition, and the fœtus was of sufficient maturity to render it worth consideration, a bag was used. Schweitzer admits that this method was attended by a fairly copious loss of blood, but gave a much better chance to the child, while if the mother has already lost considerably he considers that version is much safer for her, though attended by a high fœtal mortality. The results of these two methods worked out as 6·6% for version (chosen for bad cases) and 3·8% for the bag. This writer lays stress on the importance of institutional treatment for all cases of placenta prævia, and shows the increase of mortality, which attends those who have received some form of interference before admission, due to infection.

Wherever conditions are good he thinks that Cæsarean section will be the treatment of the future. This view is also held by Ganssle (5), who states that it is the ideal treatment provided that the child be living and viable, and that there are no manifest signs of infection at the time of the operation. He also states that rupture of the membranes is all that is required for the lateral cases with slight bleeding and a vertex presentation. In this writer's hands, from the clinic at Tubingen, the mortalities of Cæsarean section and vaginal delivery of the mother are 6·4% and 8·7% respectively, and

6·4% and 54·3% for the child. Though Cæsarean section is chiefly done when the child is sufficiently mature to survive, yet it is still to be recommended if the child is dead or non-viable, provided that the hæmorrhage is likely to be dangerous.

Conrad (6) discusses the results obtained at the Virchow Hospital from 1906–1924. Cæsarean section, usually by the lower cervical incision, was the chief method, but it was not adopted if the child was unlikely to survive delivery. The mortality of the operation was 9·8%, of version 7·5%, and of metreurysis 11·6%. The fœtal mortalities were : Cæsarean section 5%, version 50%, metreurysis 16·3%.

It is obvious, therefore, from the above quotations that there is still a difference of opinion as to the best forms of treatment. It is the writer's opinion, however, that the cases must be chosen very carefully before decision on any particular line of treatment, and, secondly, that it is not so much the particular form of treatment which may be at fault, but the conduct of the subsequent labour. It is very true that a slow labour, with the least possible interference after measures for the arrest of the hæmorrhage have been effected, is the best possible for the patient, as it affords time for thrombosis in the separated vessels of the placental site, and opportunity for cervical dilatation without tearing. There is nothing new in this. Herman taught it many years ago, but it is true that still the delivery is hurried in the belief that the labour must be completed quickly to arrest the bleeding. The chief mortality from placenta prævia arises in this country from the shock of quick delivery following blanching hæmorrhage. It is comparatively few women who actually die from loss of blood before delivery. For example, of nineteen women who died at Queen Charlotte's Hospital from the effects of placenta prævia, all died after delivery except one. It is the shock of delivery superimposed upon the acute anæmia which is so often fatal. If, therefore, after arrest of the hæmorrhage by version or other suitable means, sufficient interval of time

elapses before delivery, during which recovery from anæmia can have a chance, the outlook will be greatly improved. But if, on the other hand, severe manipulations, such as manual dilatation of the cervix followed by internal version and immediate extraction, are carried out for a woman exsanguinated by a severe hæmorrhage, the worst possible treatment is being adopted, and a fatal issue is almost certain. These considerations, therefore, bring us back to the question of the general condition of the patient as being more important than the maturity of the child, the position of the placenta, or any other feature of the case. In most reviews of the results of treatment, chiefly statistical, this all-important feature is largely overlooked. If the condition is good when she first comes under hospital treatment, and means for the arrest of hæmorrhage appropriate to the position of the placenta are carried out at once, the outlook is extremely good, but if the patient is already blanched when first seen, then great judgment and skill are required. The least possible interference compatible with the arrest of further loss with transfusion of blood and a long interval before delivery are the best combination for ensuring a successful issue. Cæsarean section has no place in the treatment of the blanched patient. Some gentle vaginal method is infinitely to be preferred. The older methods of version or metreurysis involve a variable amount of intra-uterine manipulation with the risk of still more bleeding, while mere rupture of the membranes may not be enough. But the newer method of plugging of the vagina, when carried out properly, is so sure a means of arresting bleeding while at the same time causing little shock by interference that I have ventured to deal with it in detail. See p. 90.

Treatment of Placenta Prævia by Traction on the Fœtal Head

Willet (7) has recently suggested that pressure should be exerted on the placental site by employing traction on the

fœtal head by means of a special pair of forceps which grasp the scalp where it presents above the internal os. His paper, of the nature of a preliminary report, is based upon only a few cases, but in view of the promise of continued success by the use of this method I feel justified in referring to it in this work. The forceps is a modification of hæmostatic scalp forceps used in cranial surgery.

The grasping portion is $\frac{3}{8}$ in. (1 cm.) long, set at right angles to the handle and carrying two teeth. The handles are $7\frac{1}{4}$ in. (18 cm.) long, and gently curved.

This instrument can be used in any vertex presentation where the placenta does not completely cover the os, and where the os is a finger or more dilated. It will be seen, therefore, that it affords a simple method of treatment of a difficult type of case, *i.e.*, a vertex presentation with a small os, and might be used as an alternative to plugging the vagina.

To carry out the treatment the forceps is passed through the os and pressed against the head, which is held in position from above. It is then opened and closed against the scalp, thereby securing a portion in its jaws. A weight of from 1 to 2 lb. is affixed to the handle of the instrument and slung over the end of the bed. Willet has found in all his cases that this amount of weight is sufficient to set up enough pressure on the placental site effectually to prevent any further bleeding. Labour progresses normally, and dilatation is assisted by the gentle continuous traction of the weight. A certain amount of trauma of the child's scalp is inevitable, but in the majority of cases this has been unimportant. Occasionally a cephalhæmatoma has been produced which has required some time for absorption, but no case of sloughing or gross damage has been noted.

The chief advantage of this method appears to be its simplicity, requiring little special skill and a minimum of intra-vaginal manipulation.

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CHAPTER VI

PROGNOSIS AND TREATMENT OF ECLAMPSIA

The recent investigation of the prognosis and results of treatment of eclampsia by the London Committee, of which the writer is a member, appointed by the Section of Obstetrics and Gynæcology of the Royal Society of Medicine, has brought to light many points, the full significance of which has not been completely understood. Though the report does not, perhaps, bring us in reach of finality, it has emphasised certain features of prognostic importance, and has indicated certain broad lines of treatment, which mark a step nearer the goal. The following account is based upon the findings of the London Committee :—

I. Prognosis

It is a common experience that eclampsia is one of the most difficult of all diseases to prognose on account of the possibility of sudden and unforeseen changes developing, even while the patient is under the full influence of treatment. However mild may be the apparent course of the disease, it is wise never to be too confident of a favourable outcome until the patient is definitely convalescent.

On the other hand, recovery can occur after severe and prolonged eclampsia.

An experience and analysis of large numbers of cases does, however, bring to light certain symptoms and signs which are of grave import, thus rendering it possible to classify any given case as mild, and therefore likely to end favourably ; or severe, in which the mortality rate is very high.

The clinical phenomena of chief importance for purposes

of prognosis appeared to be coma, number of fits, temperature, blood pressure, pulse rate, amount of albumin in the urine, and the degree of œdema.

Coma.—Probably of all the symptoms coma is of more value than any other single symptom as an index of severity of toxæmia. Other things being equal. we find that the mortality rate rises very steeply according to the depth and duration of the coma.

For clinical purposes coma can be described as " deep coma " from which the patient cannot be roused, " coma " in which a stimulus such as a needle prick will provoke some sort of response, and " drowsiness " in which the patient can be made to speak by attempts to waken her.

Under this classification the London Committee found results as follows :—

Series I.—262 *Cases*

Degree of coma.	No. of cases.	Incidence.	Died.	Mortality.
Deep coma .	60	22·9%	38	63·4%
Coma . .	93	33·5%	19	20·4%
Drowsiness .	109	41·6%	6	5·4%

Series II.—123 *Cases*

Degree of coma.	No. of cases.	Incidence.	Died.	Mortality.
Coma . .	75	—	21	28·0%
Coma absent .	48	—	2	4·1%

Considering the two series together, we find that the mortality of patients having coma is 34·2%, of " deep " coma 63·4%, and where there is only drowsiness 5%.

There is, therefore, a very striking difference in the outlook between those patients who have persistent and deep coma

and those who have nothing more than drowsiness. The onset or disappearance of coma while a patient is under treatment is also one of the best indications of the effect of treatment; indeed, a deepening of coma is probably a more serious symptom than the occurrence of fits. Cases are occasionally met with in which there is no coma, but continued suppression of urine with few or even no fits. This is a very serious condition and usually terminates fatally.

The Number of Fits.—Of 426 cases the average number of fits in patients who recovered was 6·8, while of the fatal cases the average was 12·7. It appears, therefore, that the actual number of fits is important, and after seven fits the condition must be considered as increasingly serious. In addition to the number, other less easily measurable details, such as the severity, duration, and rapid sequence of fits, are of great importance. A woman may be able to tolerate many slight transient fits which may be little more than twitchings, while one prolonged tetanic convulsion may strain every vital process of her body.

The period of pregnancy at which fits first occur has little influence on the mortality. From the middle of pregnancy to full term the mortality only varies between 17·9% and 24·4%. The effect on mortality of the number of fits *before treatment* shows definitely that treatment has some value and that the sooner it is instituted the better. Thus of 109 patients who recovered the average number of fits *before treatment* was four, while of twenty-seven who died the average number of fits was seven.

The effect of the time incidence of fits in relation to labour is shown by the following table :—

Time of onset.	No. of cases.	Died.	Mortality.
Before labour . .	287	59	20·5%
During labour . .	84	14	16·6%
After labour . . .	76	21	27·6%

It will be noticed that, contrary to the usually accepted belief, post-partum eclampsia (in London) bears a much higher risk than the other forms.

Temperature.—Fever, like coma, is an index of the toxicity of the disease. It is almost independent of the number of fits, for commonly one sees cases having a large number of rapidly repeated fits with little or no temperature, while again we may see the temperature steadily mount after fits have ceased.

The following table illustrates this :—

Highest temperature.	No. of cases.	Died.	Mortality.
Above 103° . . .	39	29	74·3%
100° to 103° . . .	125	14	11·2%
Below 100° . . .	187	11	5·9%

A steadily rising temperature, whether fits have ceased or not, is therefore a most unfavourable sign, while hyperpyrexia is always a fatal condition.

Blood Pressure.—The raised blood pressure in nearly every case of eclampsia is difficult to co-relate with other symptoms. It seems that where the tension is high fits are more likely to supervene, though it is quite a common experience to see fits with a tension of less than 150 mm. Similarly, the mortality rate is not so clearly related to the height of the blood pressure as, for example, to the temperature. This is illustrated by the following figures :—

Height of blood pressure.	No. of cases.	Died.	Mortality.
Below 140 mm. . .	19	4	21·0%
140 to 200 mm. . .	55	11	20·0%
Above 200 mm. . .	11	4	36·0%

Pulse Rate.—The quality of the pulse is probably of more importance than the rate. Cardiac dilatation is common in eclampsia where the tension is very high or there are many fits, and, therefore, the quality of the pulse in the later stages of the disease should be particularly noted.

According to the rate the mortality was as follows :—

Rate of pulse.	No. of cases.	Died.	Mortality.
Over 120 . . .	110	44	40·0%
120 to 90 . . .	159	15	9·4%
Below 90 . . .	74	4	5·4%

Amount of Albumin.—The degree of albuminuria is of less importance as a criterion than is generally believed. It will be noted that the mortality where the albumin solidified was very little higher than that for the whole series (22%).

Amount of albumin.	No. of cases.	Died.	Mortality.
None	2	—	—
Small amount (" cloud ").	38	3	8·0%
Large amount (" deposit ")	213	30	14·0%
Solid on boiling . .	130	33	25·3%

Œdema.—It is impossible to describe any accurate standard of œdema, but it can be grouped into three clinical classes, according to whether there is none, " slight," or " great and universal " over the whole body.

The experience of the London investigations was that œdema was a favourable sign, while in those patients who had no œdema the mortality was nearly twice as great. The mortality rates were respectively 16 and 29%.

From a survey of the foregoing clinical data it is possible

to reduce cases of eclampsia into two rough groups of intensity. A severe case might be described as one having a rapid succession of more fits than seven, with deep coma and a rising temperature reaching 103 or above, while the addition of solid albuminuria and a blood pressure of over 200 would still further prejudice the prognosis. On the other hand, a mild case is one in whom a few fits only occur, probably during the second stage of labour, who rapidly regains consciousness after each short fit, with a normal temperature throughout, and a comparatively low blood pressure and slow pulse. It should be remembered, however, that any so-called mild cases may, while under treatment or even after delivery, suddenly develop serious symptoms such as deep coma or suppression of urine, from which they may not recover.

For the purposes of classification the London Committee agreed that if a patient exhibited any two severe symptoms, such as deep coma, many fits, temperature over 103, etc., the case should be grouped as "severe," but the absence of two or more warranted the case being described as "mild." Under this classification the general mortality worked out as follows :—

Group.	No. of cases.	Deaths.	Mortality.
"Mild" . . .	264	17	6·4%
"Severe" . . .	161	52	32·4%
"Moribund" . . .	14	14	100%
Total . .	439	83	18·9%

The great difference between the mortality of the mild and severe cases classified on this arbitrary basis seems to justify the method as sound from the clinical point of view.

Effect of the Treatment

Before discussing the various details of treatment, it will be well to describe the broad lines which it may follow, and the general results which have been obtained.

For many years there have been two main tendencies in the treatment of eclampsia, one in the direction of active measures aiming at immediate or rapid delivery, chiefly practised in Germany and America, the other inclining towards elimination of the toxins and prevention of the fits by sedative drugs, which has had its champion in Strogonoff, of Petrograd.

On theoretical grounds it would appear, *à priori*, that termination of the pregnancy as rapidly as possible would be most likely to succeed, inasmuch as without pregnancy the disease does not exist. Treatment based on this elementary principle has not, however, been successful, and opinion has now definitely swung round to the conservative method. The results of conservative treatment, published by Strogonoff from time to time, have shown a strikingly low mortality rate, and he has recently told the writer during his visit to this country that of his last eighty cases there has been no death. The investigations of the London Committee also have produced very strong evidence of the comparative safety of conservative treatment and danger of radical measures, though it must be confessed that conservative treatment as practised in this country cannot approach the favourable results claimed by Strogonoff.

A commentary on the value of radical treatment is provided by a study of the effect of delivery on the incidence of post-partum fits, and the comparative mortalities attendant upon those who have, and have not, fits after delivery. One of the chief contentions of those who practise radical treatment is that the evacuation of the uterus is the surest method of arresting convulsions and therefore of curing the disease, but if it can be shown that the mortality is unaffected by the

continuation of fits after delivery the principal sanction for radical treatment falls to the ground.

An analysis of the material studied by the London Committee is as follows :—

Total No. of cases studied.	No. of cases in which fits persisted after delivery (post-partum eclampsia omitted).	Incidence.
413	118	28·5%

The first point is, therefore, that nearly one-third of all cases continue having fits after delivery. A further analysis shows that the incidence of fits continuing after delivery is about one-third less in the "mild" than in the "severe" cases.

The mortality of the 118 is as follows :—

No. of cases with fits after delivery.	Died.	Mortality.	Mean mortality of whole series, 547 cases.
118	26	22·1%	22·1%

Gravity of case.	No. of cases	Mortality.	Mean mortality of all cases.
"Mild" . .	36	—	6·4%
"Severe" . .	48	31·0%	32·4%

No. of cases with no fits after delivery.	Died.	Mortality.	Mean mortality of whole series.
295	64	21·6%	22·1%

From these figures we may make the following general deductions :—

1. Fits cease with delivery in nearly three-quarters of all cases.

2. In the " mild " cases the persistence of fits after delivery has no influence on the result, as all of these patients lived.

3. In the " severe " cases the risk was almost the same whether the fits persisted after delivery or not, *i.e.*, the mortality of severe cases was the same whether the fits ceased after delivery or not.

The actual results of certain broad lines of treatment which have been studied by the London Committee are instructive inasmuch as they show clearly that in the average cases of eclampsia a favourable issue is less likely to follow when active obstetrical treatment has been followed.

Gravity of case.		Died.	Mortality.	Mean mortality.
Natural Delivery				
Mild cases . .	50	3	6·0%	12·3%
Severe cases .	39	8	20·5%	
Induction of Labour and Spontaneous Delivery				
Mild cases. .	59	3	5·1%	9·6%
Severe cases .	24	5	20·8%	
Assisted Delivery (*Low Forceps and a Few Versions*)				
Mild cases .	100	5	5·0%	14·5%
Severe cases .	51	17	33·3%	
Cæsarean Section				
Mild . .	51	5	9·8%	23·8%
Severe . .	37	16	43·2%	
Accouchement Forcé				
Mild. . .	4	1	25·0%	50·0%
Severe . .	10	6	60·0%	
Mean Mortality of all Cases (425) :				
Mild.				6·45%
Severe				32·4%

From these results it is clear that the most favourable methods of treatment are those which interfere least with the patient, and that surgical interference is much more harmful than allowing the child to remain *in utero* while medical treatment is being carried on.

For example, Cæsarean section raises the mortality in mild cases from an average of 5·3% when treated by nothing more than induction or low forceps to 9·8%, *i.e.*, nearly double. In severe cases the average mortality of the simpler methods of treatment is 24·8%, while with Cæsarean section the death rate rises to 43·2%, again nearly double.

In spite of the well-known fallacies of the statistical method in medicine, it is permissible to argue that this investigation has shown unmistakably that Cæsarean section is an unsuitable treatment for eclampsia.

These conclusions are also supported by Professor Strogonoff in his advocacy of his " improved prophylactic method " (conservative treatment), in which he reports a mortality of only 1·7% in 230 cases, and later, the most recent series of eighty cases with no mortality.

He further states that in " unneglected cases " it will be possible to obtain the following results if his method is " closely adhered to " :—

" 1. Recovery of mothers, 100%.

" 2. Very great probability of preserving the life of the child, 90% (approx.).

" 3. Appreciable probability that the fits will cease immediately treatment is commenced, 90% (approx.)."

How far such successful results may follow the general adoption of Strogonoff's treatment in this country it is impossible to say, for it seems probable that eclampsia in Russia is of a milder order than in Great Britain.

It is only fair to add that Strogonoff insists on his scheme of treatment being followed exactly as he lays it down, and that he cannot be held responsible for patients treated by modifications of his own method.

As an illustration of Strogonoff's method we will give the notes of a case treated by him admitted under the care of the writer to Queen Charlotte's Hospital in July, 1924 :—

Mrs. X., II.-para of 26, admitted July 26th at 11.30 a.m. after one fit at home and another on arrival at hospital. There had been severe headaches, œdema, vomiting and albuminuria.

Pregnancy had advanced to thirty-four weeks, the child was alive, labour pains were not present, and the patient was partially comatose. Bl. pr. 138, P. 85. The urine became solid with albumin on boiling. After examination Professor Strogonoff regarded the case as being "between mild and severe."

The following treatment was instituted at once :—

The room was darkened and all possible noise was prevented. No unnecessary examinations were made, any disturbance of the patient was carried out under chloroform.

26.7.24. 11.30 a.m.—Chloroform inhalation (℥ij) immediately on arrival, for ten minutes.

11.45 a.m.—Injection of morphia (under chloroform) gr. $\frac{1}{3}$ (0·02 gm.). The dose was larger than the usual (gr. $\frac{1}{4}$) on account of the relative severity of the case, the "strong constitution" of the patient, and "the great noise of street traffic."

11.55 a.m.—Blood pressure 138, pulse 70, temperature 98·6.

12 noon.—Chloroform inhalation (23 minims or 1·5 c.c.), during which a catheter was passed, yielding ℥iv of urine.

12.15 p.m.—Chloroform inhalation (45 minims or 3 c.c.).

12.25 p.m.—Rectal injection of :—

Chloral hydrate . .	gr. xxx
Aqua dest. . . .	℥j ℥ijss
Milk	℥ij
Normal saline. . .	℥iij ℥ijss

Given under chloroform inhalation (♏xxiij).

Part of this enema was returned ; therefore at :—

1.25 p.m.—Rectal injection :—

Chloral hydrate . .	gr. xv (1 gm.).
Aqua dest. . . .	℥v
Milk	℥j (30 c.c.).
Normal saline. . .	℥j ℥v (50 c.c.).

2.25 p.m.—Injection of morphia, gr. $\frac{1}{4}$ (0·015 gm.) given under chloroform (℥ss or 2 c.c.).

2.30 p.m.—Patient became conscious and spoke intelligently.

4.25 p.m.—Rectal injection under chloroform (♏ 40) :—

Chloral hydrate . .	gr. xv
Milk	℥j (30 c.c.).
Normal saline. . .	℥j ℥v (50 c.c.)

6.25 p.m.—Blood pressure 154, pulse 70, temperature 98·4 (taken without chloroform) sleeping.

9.45 p.m.—Rectal injection under chloroform (♏ 42) :—

Chloral hydrate . .	gr. xv
Milk	℥j
Normal saline. . .	℥j ℥v

Urine passed voluntarily ℥vj

Patient moved under chloroform to another ward.

27.7.24. 5.35 a.m.—Rectal injection as above, without chloroform.

2.40 p.m.—Chloral hydrate gr. xv and milk by mouth.

3.30 p.m.—Rectal wash-out.

Patient is quite conscious and in good condition except for headache.

10.10 p.m.—Cascara ℥ij.

During the third and fourth days chloral was given two or three times daily.

This patient recovered entirely from her attack of eclampsia without any interruption of pregnancy, which was allowed

to progress until the beginning of September. Labour was finally induced owing to cessation of fœtal movements, and a macerated fœtus was delivered.

Other important points in Strogonoff's method are :—

1. *Treatment of Labour.*—Nothing is done unless there is a special indication such as delay in the second stage, when forceps may be applied. Rupture of the membranes towards the end of dilatation is of value, and should be done earlier in the multipara.

All manipulations must be carried out under chloroform anæsthesia.

2. *The General Condition.*—The heart is treated by digitalis if the pulse rate is over 110, and for weakness due to dilatation camphor or other stimulant is given.

3. It is important to treat asphyxia after the fits by oxygen, and to clear the air passages of mucus and blood. Strogonoff also changes the position from right to left side from time to time to avoid hypostatic pneumonia.

4. Sweating and diaphoresis are encouraged by warm clothing, hot bottles, and fluid freely given by mouth.

5. The lower bowel is cleared out by an enema, but no strong purges are given, and no lavage of stomach and colon is done.

6. Strogonoff's rule for venesection is that if seven fits have occurred before admission to hospital, or if three fits occur after starting treatment with no early prospect of delivery, 15 oz. of blood are withdrawn.

It will be seen from the foregoing account that Professor Strogonoff chiefly relies upon stopping the fits by sedative drugs in the shape of chloroform, morphia and chloral, and strict prevention of all possible external stimuli such as light and noise and manipulation, while he leaves the patient largely to detoxicate herself by her own unaided excretory organs. It is true that an enema is given and an aperient on the second day, and diaphoresis is gently encouraged, but such eliminative measures are entirely secondary to the direct

treatment of the fits, and play much less part in the general management of the disease than the methods usually adopted in Dublin and England.

A further important point of difference is the use of chloroform. In this country chloroform has been regarded with great disfavour on account of its known deleterious action on the liver cells and its tendency to cause acidosis. It is argued that in such a condition as eclampsia, where we know there is a possibility of hepatic impairment, it is dangerous to administer a drug which can have a similar effect and thus intensify such damage as may be present.

It must be admitted, however, that these objections are largely theoretical, and they must be judged in the light of the clinical experience not only of Strogonoff and his fellow workers, but also of the older English obstetricians who habitually and successfully used chloroform in former days.

The so-called "Dublin method" of treatment is largely based upon the theory that eclampsia is due to auto-intoxication from the bowel. It is a conservative method which claims to have reduced the mortality to the region of 9%. The chief items of this method are gastric and colon lavage, together with subcutaneous infusion of sodium bicarbonate in saline and morphia gr. $\frac{1}{4}$, repeated if the fits do not cease.

A further conservative method is that in use at Queen Charlotte's Hospital. Under this scheme the bowel is washed out, but no stomach lavage is done. Veratrone is given if the blood pressure is high as follows :—

Above 190 mm. . . .	1 c.c. hypodermic injection.
175 mm. to 190 mm. .	$\frac{3}{4}$ c.c.
160 mm. to 175 mm. .	$\frac{1}{2}$ c.c.
140 mm. to 160 mm. .	$\frac{1}{4}$ c.c.
Below 140 mm. . .	No veratrone.

No food is given by mouth, but a saline aperient and water if the patient can swallow. Morphia is given only for restlessness, and atropin for pulmonary œdema. If there is no

œdema saline infusion is given either subcutaneously or intravenously. Induction of labour is done after the eclampsia attack has passed, by rupturing the membranes and the introduction of a small bag. If labour is in progress nothing is done unless there is an obstetrical indication such as delay or mal-presentation.

It will be observed from a perusal of these representative methods of treatment that opinion has steadily moved away from active interference aiming at rapid delivery, and is veering round in the direction of the medical and conservative method of Strogonoff. There is variation in the details of the methods, but the general principles are the same.

CHAPTER VII

THE SCOPE AND RESULTS OF CÆSAREAN SECTION

Indications

The last few years have seen a considerable modification of opinion on the indications for Cæsarean section.

It was natural that with the perfection of technique of a comparatively simple operation which is capable of saving so much time and labour, there should be a tendency to magnify its advantages and minimise its less attractive features. The most striking point to the inexperienced operator who has successfully accomplished one or two Cæsarean sections, is the ease of the technique and its sharp contrast with the tedium, anxiety and fatigue of a difficult labour.

It was only natural that under such stimulating circumstances, and in the absence of strong and informed guidance from experienced obstetricians, there was a tendency for the operation to be done widely and frequently in response to an ever-extending group of so-called indications. Indeed, the prevalence of Cæsarean section was largely in inverse proportion to the degree of obstetrical knowledge, judgment and skill possessed by the operator. Now, however, the increasing personal experience of individual operators, together with the information gained by the recent inquiry into the after-results of the operation (Eardley Holland), have done much to clarify our ideas, and curb the initial enthusiasm for what at first promised to be a short and easy way out of almost any obstetrical difficulty.

It is now fully realised that the operation, though com-

paratively easy to perform, is not without its dangers or unpleasant sequelæ. The mortality risk, even in deliberate cases, is four times that of labour, while for some of the obstetrical emergencies the mortality may rise to over 20%. We find, therefore, a tendency to reduce the number of indications to a few well-tried conditions in which experience has shown us that the results for both mother and baby are greatly improved by Cæsarean section.

1. **Contracted Pelvis.**—A. When seen before labour there are certain degrees of pelvic contraction which must be treated by Cæsarean section if a live baby is to be born. These extreme degrees are rare and often exhibit obvious signs of rickety deformity. If the brim or outlet are so reduced in capacity as not to allow a thirty-two weeks child to pass, the chance of a live baby able to survive induction of premature labour at that early date is almost non-existent, and Cæsarean section becomes an unquestioned necessity.

Statistics of prematurity at Queen Charlotte's Hospital worked out by Eden show that before thirty-six weeks a child's chance of survival is not sufficiently good to justify induction of labour unless Cæsarean section is contra-indicated, whereas at or after thirty-six weeks the child appears to be able to survive almost, if not quite, as well as at full term. A useful working rule to adopt, therefore, is that Cæsarean section should be advised if the relation of a floating head to the pelvis is such that it cannot be pushed down at the thirty-sixth week or before. Under these circumstances the head may be ultimately moulded and pulled through, but only at the expense of fatal intra-cranial injuries, and Cæsarean section is the better way. If, however, a high head can be pushed down at the thirty-sixth week or after, induction of labour may be practised at the appropriate time, especially if the woman be a primigravida, or the pelvis flat and not generally contracted. Owing to the unexpectedly easy deliveries which are commonly seen in primigravidæ with simple flat pelves, it is unwise to recommend

Cæsarean section until the progress of descent has been watched during the early stages of labour. With multiparæ we have the advantage of knowing the history of previous labours and can therefore gauge more accurately the necessity for Cæsarean section. In general it may be stated that, for any multipara who has previously had labour induced with loss of the child either at or just after labour, Cæsarean section is justifiable for the forthcoming delivery rather than another attempt at induction.

Further, markedly contracted measurements of the pelvis, together with a mal-presentation which cannot be corrected, warrant a Cæsarean operation in a primigravida and also in a multipara if there is a history of previous difficult or induced labours.

Reference has been made above to the "trial labour." It is a term used to denote a labour which is being closely watched with a view to terminating it by Cæsarean section should the head not show signs of engagement and descent.

In spite of great care in examination, there are some cases, chiefly primigravidæ, who cannot confidently be estimated. Such patients are commonly those who have a slight degree of simple flat pelvis, and who may or may not be able to mould the head through the brim. In doubtful cases of this kind it is permissible to allow labour to begin either by induction or naturally under close observation for the first few hours. No vaginal examination should be made for fear of introducing an infection which would render a subsequent Cæsarean section more risky.

Attention is devoted to the high movable head by abdominal examination. If the head is going to pass the brim spontaneously the observer will notice, in order of occurrence, firstly, fixity and settlement of the head over the brim in place of the high and freely mobile condition which existed before labour; secondly, flexion, as shown by the appearance of a prominent forehead and correspondingly less prominent occiput, with a disappearance of the major portion of the head

into the brim, and any overlapping that may have existed; thirdly, descent of the head, except the forehead, which, finally, can alone be felt on one or other side, indicating full flexion. The last two stages may not be seen until after the rupture of the membranes, which will allow the uterus to obtain direct driving power on the fœtus. Should no progress as described above be obvious with strong pains by two hours after the membranes have ruptured, it is justifiable to assume that a living child *per vias naturales*, will not be born and therefore to terminate labour by Cæsarean section. The objection to terminating a "trial labour" by Cæsarean section is the danger of infection, but this is no greater than when the operation is done before labour, provided no vaginal examinations have been made or the membranes ruptured for more than about two hours. It is true that a minimum of vaginal examinations made under strict precautions involve very little risk, but it is undoubted that from the time the membranes are ruptured there is a distinct danger which rapidly increases as time passes. Every care should, therefore, be taken in a "trial labour" to carry out the minimum number of vaginal examinations under the greatest care, and not to delay the operation, if it is to be done, more than two hours after the membranes have been ruptured.

B. When first seen during labour. Considerable debate has raged around the question of the justifiability of performing Cæsarean section during labour after the failure of vaginal attempts at delivery. The "failed forceps" case is one of the most difficult of problems of all midwifery if the child is still alive. Not infrequently the failure is due to the application of the instrument before sufficient time has elapsed for moulding to take place, but occasionally forceps will fail even with good pains and adequate moulding. If the child is still vigorous, the problem of delivery is a very serious one.

The chief risk of operation is sepsis, either of the peritoneum,

uterine or abdominal walls. A lesser risk is shock added to that already produced by abortive attempts at forceps delivery, and possibly prolonged chloroform anæsthesia.

The septic possibilities directly due to Cæsarean section are general peritonitis, from which recovery is scarcely possible, and infection of the uterine and abdominal walls, which will result in adhesion of the uterus to the abdomen, with chronic stitch sinuses and possibly a permanent uterine fistula.

Between the extreme views of never performing the operation after vaginal examination has been made with ruptured membranes and, on the other hand, allowing it after repeated attempts at forceps delivery under questionable or unknown conditions, it is permissible to take a medium line of action which may save some babies' lives without undue risk to the mother.

The cases may be grouped into definite clinical types as follows :—

(*a*) The exhausted woman with certainty of infection, as shown by an offensive discharge, or history of multiple attempts at forceps delivery in dirty surroundings.

Under these circumstances the operation is entirely unjustifiable, and should on no account be done. The child is probably, almost certainly, distressed, and its delivery by Cæsarean section would scarcely enable it to survive, while the risk to the mother would be very great. Craniotomy is the only treatment for such a case.

(*b*) A woman in good general condition has had forceps delivery attempted under clean surgical circumstances, with every antiseptic care. The fœtal heart is vigorous and of normal rate. Cæsarean section may perhaps be performed here, though it must be clearly understood that the risk to the mother is distinctly greater than if the operation had been done before attempts at delivery.

To minimise the risk of sepsis as far as possible, it is well to modify the technique of the operation as follows : The

vagina should first be swabbed thoroughly with a suitable antiseptic such as "methyl green." The abdominal incision should be made large enough to eventrate the whole uterus before opening it, and the space between the uterus and abdominal wall should be carefully packed to prevent liquor amnii from falling into the peritoneal cavity. After removing the child the placenta should be separated and pushed down into the vagina and the uterine cavity should be swabbed all over with "methyl green" solution (brilliant green $\frac{1}{2}\%$, methyl violet $\frac{1}{2}\%$ in spirit). An alternative is to pack the uterus with gauze soaked in eusol and suture the uterine walls over the gauze, which is removed per vaginam the next day. When the uterus has been sutured, a fresh set of instruments and towels are used for sewing up the abdominal wall.

(*c*) The patient has been in labour long enough to judge whether the head will engage and pass the brim. The membranes have not been ruptured more than about four hours, and only the most careful vaginal examination has been made. This virtually amounts to a case of "trial labour," and here Cæsarean section may be done with very slight extra risk.

The Risk of Cæsarean Section done on Infected Cases

The average mortality of the operation done before, or early in, labour is about 2%. Routh's series of 469 cases between 1891 and 1910 yielded a mortality of 2·9% for non-infected cases, while Munro Kerr and Holland's series of 1,591 cases done by British surgeons between 1911 and 1920 produced a mortality of 1·6%.

Where labour has progressed to a late stage, or repeated examinations or attempts at delivery have been carried out, the mortality rate rises sharply.

The causes of death are shock following an exhausting labour, general peritonitis, septicæmia, pulmonary embolus,

cardiac failure, hæmorrhage and intestinal obstruction. But, in addition to the grave risk incurred during the puerperium, there are other remote dangers which may ultimately lead to a fatal issue. Of the less acute results of operating on an infected field are failure of the uterine walls to form a firm and complete union, adhesion of the uterine, and abdominal scars and adhesions between the uterine wall and intestine or omentum.

Series.	Cases.	Mortality.	
Kerr and Holland .	220	10%	Late in labour.
Kerr and Holland .	107	27%.	After forceps application.
Routh . . .	230	17%	Membranes ruptured, examinations, or forceps application (1).

The imperfect union of the edges of the uterine wound may lead to rupture of the uterus during a succeeding pregnancy or labour, or even peritonitis after a repeated Cæsarean operation due to incision through an infected cyst enclosing a stitch in the uterine wall.

It is true that some obstetricians regard the risk of Cæsarean section in infected cases with less pessimism, especially if a modified technique, as described above, is employed, but, nevertheless, the fact remains that the risk is great, and our first consideration is the safety of the mother, who may live to have other children.

A further consideration that should be weighed by an operator contemplating Cæsarean section for a "failed forceps" case is the possibility of securing a child which will ultimately survive. The child which has suffered much traction on and compression of its head by forceps will always suffer depressed vitality, as shown by a slow and faint heart beat. For the operation to be done for the sake of the child

and at risk to the mother it is not enough that the fœtal heart should be heard. It must be heard beating vigorously and at a reasonable rate, *i.e.*, not below about 120. Blacker has shown that when Cæsarean section is done after failure with forceps only 50% of the children leave the hospital alive. This is a very heavy mortality among the children, and cannot be said to justify a measure which puts the mother to so great a risk. In addition to children who fail to survive, there are others who have sustained non-fatal cranial injuries which cripple their development in after years and render them useless as citizens. In addition, therefore, to the grave maternal risk the poor chance of securing a healthy baby renders Cæsarean section after repeated failure with forceps a deplorable operation.

Ante-partum Hæmorrhage

1. **Placenta Prævia.** — The increasing popularity of Cæsarean section has led to its widespread application in the treatment of placenta prævia. A superficial view of the ease of the operation on the one hand, and the difficulties and dangers of vaginal delivery on the other, leads the inexperienced to think that surely the latter method of delivery should be reserved for only the mildest cases. A sufficiently long experience of the results of Cæsarean section for placenta prævia will considerably correct the first impression, especially if time has brought a corresponding increase of skill in the method of vaginal manipulation.

Since the initial enthusiasm has worn off we have come to recognise a well-defined group of cases which are properly treated by Cæsarean section, and also conversely that the majority of cases are better treated by the older methods of vaginal delivery. There is no doubt that the operation will afford the child a very much better chance, and it is for this reason that it is so strongly advocated by some obstetricians. But here again we must consider the mother first, especially as the child is often premature and unlikely to survive.

The special dangers of the operation for placenta prævia are :—

1. Shock due to abdominal section in a woman who is exsanguinated. A patient who is blanched and with a pulse of 130 or over is in a very critical condition for Cæsarean section. The severity of placenta prævia is usually judged by the degree of blanching, and, according to this criterion, we may say that the worse the condition is the more unsuitable and risky the operation. It is very important to grasp the fact. Commonly we are urged to operate the greater the extent of the anæmia, because the patient is in a grave condition and the operation is presumably of greatest use for the worst cases. But experience shows that it is just this severe blanched condition that must be treated by the most conservative measures possible.

2. The other noteworthy danger of Cæsarean section is hæmorrhage taking place from the denuded lower segment while the uterine incision is being sutured. It is not obvious that bleeding is going on as the blood passes down the vagina and on to the table. The lower segment is particularly prone to bleed at this time as the hand has separated the whole of the placenta suddenly from an area that has comparatively little contractile power. During the course of vaginal delivery, a small piece of the placenta only is detached at any one time, and opportunity for thrombosis of the open blood sinuses occurs before a further separation takes place, but during Cæsarean section the whole placental site is suddenly stripped, and much hæmorrhage can take place even though the fundus which is being sutured is firmly contracted. If the patient has already lost freely, a small amount of blood escaping unnoticed during the operation may be very serious. This form of bleeding is difficult to arrest, and it can only be done by grasping the lower segment firmly.

In spite of the special dangers of the operation, there is, however, a definite place for it in the treatment of placenta

prævia, and if the cases for operation are chosen with judgment, the results will be gratifying. The type of case most suitable for Cæsarean section is the primigravida with a central placenta prævia who has lost a small or moderate amount of blood before labour at or near full term. Here we have a woman with a live and mature baby who may expect to have a fairly prolonged first stage of dilatation with consequently much opportunity for inevitable hæmorrhage. Moreover, any vaginal manipulation necessary for initiating labour must cause a considerable amount of bleeding, and the outlook for the child is almost hopeless. Instead of great risk to the mother and almost certain loss of the child, we can greatly reduce the maternal risk, and make sure of a living child by Cæsarean section. Many obstetricians believe that all cases of central placenta prævia with a live mature baby and non-dilated or only partially dilated os should be operated upon. A further indication for operation is the presence of some mechanical difficulty, such as contracted pelvis or shoulder presentation.

Unsuitable cases for operation are, firstly, those patients who are seriously anæmic by previous heavy losses of blood. Such patients should be treated first by vaginal plugging and blood transfusion, and possibly Cæsarean section after twenty-four hours have passed. Secondly, the lateral position of the placenta, especially if there is a breech presentation with a small premature child is better treated by vaginal methods.

I may sum up by saying that it is not the amount of blood already lost which is the indication for operating, but the amount which may be expected to be lost if vaginal methods of delivery are employed. Generally speaking, the amount will be great with a placenta at the margin of, or covering the os, and a long labour, while the loss will probably be small in a multipara with a placenta which is lateral or can only just be felt an inch or so away from the margin of the os with a small baby. If such is the case and the breech

presents, the best possible treatment is to pull the leg down. At Queen Charlotte's Hospital there have been eighty cases of central or marginal placenta prævia in 1918, 1920, 1921, 1922, with the following results :—

		Died.	Mortality.
Vaginal methods of delivery .	45	8	17·7%
Cæsarean section . . .	34	2	5·9%

The fœtal results were as follows :—

		Alive after twelve days.	Still-born or died.	Mortality.
Vaginal delivery	Central and marginal .	12	39	76%
	Lateral . .	21	21	50%

		Alive after twelve days.	Still-born or died.	Mortality.
Cæsarean section	Central and marginal .	21	11	34·4%
	Lateral .	4	2	33·0%

2. **Accidental Hæmorrhage.** -The great majority of cases of accidental hæmorrhage are of minor degree, and only require simple medical treatment. From time to time, however, a case occurs with serious hæmorrhage either concealed or external, and the question of Cæsarean section will arise. As a general rule it may be stated that if labour pains are present the best results will follow the conservative

method of plugging the vagina. The patient is usually toxæmic as well as exsanguinated and less in a condition to stand Cæsarean section than a case of placenta prævia who had lost a similar amount of blood. Moreover, the presence of labour pains shows that the uterus is capable of contracting, and, therefore, of arresting the bleeding spontaneously. The difficult problem is the patient who has lost heavily, most of the blood being concealed within the uterus. Here the uterus is probably paralysed by distension and unable to contract, thus allowing continuous bleeding to leak into its cavity.

Immediate operation for patients in this anæmic and shocked condition is almost certain to end in disaster, and we feel strongly that Cæsarean section only has a place in the treatment after opportunity has been given for recovery from shock under medical measures which include tight vaginal plugging and binder, together with opium or morphia. With recovery from shock the case should be treated by operation, especially if contractions are still absent. If contractions have commenced in the meanwhile, it is probable that delivery by vagina after the vaginal plug will be more safely accomplished than by Cæsarean section.

Pelvic Tumours

A. **Fibroids.**—The only form of fibroid which will cause obstruction in labour is that which is impacted in the pelvis and remains so during the early stages of labour. It is surprising how many apparently obstructing tumours disappear from the pelvis up into the abdomen during the late weeks of pregnancy, or the first few hours of labour. If the tumour is not drawn up, or cannot be pushed up after labour has begun, Cæsarean section should be done, and the child should never be dragged past the obstruction. All cases of cervical fibroid require Cæsarean section.

B. **Ovarian Tumours.**—The great majority of ovarian

tumours become elevated out of the pelvis as pregnancy advances, but occasionally a cyst may become impacted beneath the child's head and unable to rise. If this condition is found at the onset of labour the abdomen should be opened when the os is fully dilated, the cyst pulled up and removed while an assistant applies forceps and extracts the child per vaginam. The woman is thus delivered *per vias naturales*, and the uterus remains unopened while the cyst has been removed.

Occasionally it may be found that the pedicle of the tumour is nipped by the head at the brim and cannot be pulled up from the pelvis. In this case it is necessary to open the uterus and remove the child first.

Eclampsia

Reference has already been made (see p. 114) to the treatment of eclampsia, and evidence has there been quoted showing that Cæsarean section increases the mortality of all grades of the disease as compared to other forms of treatment. It is becoming more and more apparent that Cæsarean section has no place in the treatment of eclampsia.

Hour Glass Spasm of the Uterus (Contraction Ring)

This condition, which must be carefully distinguished from the retraction ring of Bandl, is an annular constriction of the lower part of the uterus which grasps the child, usually round its neck and prevents the passage of the shoulders. It tends to develop after the membranes have been ruptured some hours, in the presence of some mechanical difficulty in labour and especially if the uterus has been irritated by intra-vaginal or -uterine attempts at delivery. The ring forms a very serious bar to delivery, and in most cases offers a complete obstruction. Its tenacity prevents any attempt at manual dilatation or passive relaxation under the influence of drugs except after twenty-four hours or more. The

contraction ring is, in fact, one of the most serious forms of obstetrical complications, and has a high maternal and fœtal mortality.

Unfortunately Cæsarean section is able to render very little assistance, as these patients when first seen have nearly always already had a considerable amount of intra-vaginal or -uterine manipulation in addition to which the liquor amnii has been lost for many hours. Under these circumstances the case must be regarded as infected, and, therefore, one for whom Cæsarean section would involve very great risk. If vaginal delivery is quite impossible as it may be with a very tight ring, the mother's best chance will be given by removal of the unopened uterus.

Before recourse to abdominal operation, however, an attempt should be made to effect vaginal delivery by means of Willett's method of continuous weight traction. The forceps, or a cranioclast, is fixed to the head, and a weight of about 6 lb. is attached and hung over the end of the bed. Morphia and atropin should be given and the patient left alone. If this method is going to succeed, delivery will probably be accomplished within four hours.

Mal-presentations

The majority of mal-presentations can be adequately dealt with by the vagina. There are some cases, however, in which the probability of a live child is small owing to a co-existing flat pelvis or comparatively advanced years of a primigravida, and here, after due explanation and setting forth of risks to the patient, Cæsarean section may be considered.

A breech presentation in a primigravida over thirty-eight years will offer a serious risk of still-birth, and it is legitimate to advise Cæsarean section if all attempts at external version have failed. It is impossible to fix an arbitrary age after which operation is advisable, for the dilating capacities of

women differ considerably, but as a general rule between thirty-five and forty labour is distinctly slower and more difficult (see p. 139).

The shoulder presentation rarely requires operation, because the early cases can be treated by version while the late impacted cases are much more safely treated by decapitation in view of the certainty that the child has already died. If, however, during pregnancy a shoulder presentation recurs repeatedly after correction, and especially if the pelvic measurements are reduced, and the patient is an elderly primigravida, Cæsarean section may be considered on account of the grave risk to the child.

The brow presentation is seldom diagnosed in pregnancy or sufficiently early in labour to render it possible to consider the operation. If seen before manipulative delivery has been attempted, and it is found impossible to convert to a vertex or a face presentation, it is legitimate to operate if the child is alive.

Miscellaneous

In addition to the foregoing there are many other individual conditions which are rare, but which may call for Cæsarean section. In general, the operation should be done for any form of obstruction which involves either the mother or child in risk of death or injury. For partial obstructive conditions, that is conditions which, while not offering an absolute bar to vaginal delivery, are liable to render it so difficult as to jeopardise the mother or child, and so raise the risk above that of a clean and deliberate Cæsarean section, including its possible sequelæ, the operation is justified.

It is impossible to define exactly which conditions properly come within the orbit of "partial obstruction," as this is a relative term which has a variable meaning according to the skill and experience of the obstetrician. An individual

definition thereof is partly derived from previous experience and partly from anticipated difficulties in some particular and impending case. Increasing experience, both of midwifery and the results of Cæsarean section, tends to increase the readiness to diagnose the probability of difficulties in labour and their proper treatment by Cæsarean section, but it is well to bear in mind that any extension of the indications for the operation should be regarded seriously not because of the results in the hands of an experienced operator, but because of the danger of a widespread adoption of the operation by those unaccustomed to this operation.

One of the commonest but least well-defined indications, which is now recognised by some obstetricians, is an age of forty or over in a primigravida, irrespective of there being present any other abnormality such as mal-presentation or contracted pelvis. It is contended that though a first labour at this comparatively advanced age may be entirely normal and even quick and easy, yet the risk of prolonged delivery with a still-born or damaged child, and much laceration of the mother is great enough to justify the Cæsarean operation. It is true that a first pregnancy at forty years may be of especial value to the prospective parent on account of the improbability of its being repeated, a point which increases the anxiety of the accoucheur and magnifies the importance of the attendant risk. Difficult labour in an elderly primigravida, with a still-born baby makes a deep impression, and inevitably stimulates the opinion that for such women Cæsarean section is the better method.

A frequent condition in elderly primigravidæ which causes anxiety and fatigue is non-dilatation of the os, especially if the membranes have ruptured prematurely. In a number of these cases it is only a matter of time, patience, and chloral or morphia before full dilatation is effected with no serious harm to either mother or child, but occasionally the os is actually rigid and dilatation is entirely held up. Recently, at Queen Charlotte's Hospital an elderly primigravida failed

to dilate the os effectually, but the head was suddenly liberated by the rim of the cervix having been entirely detached (circumferential tear) and expelled separately in front of the head. Severe sepsis followed and the patient died in a few days.

On the other hand, in the same hospital, a primigravida of forty-six was delivered safely after a labour of only five and three-quarter hours. It is undoubted that the so-called "elderly primigravida" may have a fairly easy and straightforward labour, with only ordinary laceration, and a live uninjured baby, but from time to time a case will arise, which, by its protraction or injury, will end in disaster. Nobody can foretell the character of the labour.

In practice the proper procedure is to place the facts of experience before the patient and her husband, and invite them to express a preference after guidance on the matter of relative risks. An alternative method is to allow the patient to enter labour normally at the natural time and watch carefully the progress during the earlier stages. Should the rate of dilatation be normal, the case may obviously be left to itself, but if unusual delay threatens, and if every effort has been taken to avoid unnecessary examination so that the risk of infection has been kept at the minimum, the labour may legitimately be terminated by Cæsarean section, having regard for the serious risks, described above, which may be met with.

Another type of case which may give considerable anxiety is a breech presentation which cannot be turned by external version in an "elderly primigravida." It is probable that the cause of failure to accomplish external version is extended legs, a position which can easily be verified by X-ray examination. Now extended legs will add to the difficulty of delivery and risk of a dead baby and perineal damage. A recent review of the course of 100 cases of breech labour with extended legs at Queen Charlotte's Hospital by Dr. Hall and Dr. Hilda Page showed that in 96% the legs required bringing

down either to save dangerous delay or actual obstruction. In multiparæ and many young primigravidæ this is a fairly easy and safe manœuvre if undertaken as soon as the os is fully dilated, *i.e.*, before impaction of the breech in the pelvic cavity, but for a primigravida of forty or over, the risk of still-birth is greatly increased, not only on account of the position of the legs, but because there will be, almost invariably, extension of the arms and head requiring further difficult manipulations to effect delivery. If at this stage there is much delay or force used in extracting the head through the comparatively rigid soft parts of a woman of this age, the child will be lost either by asphyxia or by intracranial lacerations (see p. 42). In view, therefore, of the risk to the child under these circumstances of presentation it is justifiable to suggest to the patient the safer method of delivery by Cæsarean section. Experience shows us that, when properly explained, most patients will gladly accept the latter method in preference to the chance of still-birth and serious laceration, which is liable to attend vaginal delivery. Apart, therefore, from the recognised indications for the operation, there are a number of less well defined circumstances which render Cæsarean section the method of choice. A proper decision can only be arrived at by a process of weighing risks after a full examination of all the factors in the light of previous experience of one's own and that of others embodied in their teaching. Care must be taken to guard against a too ready acceptance of what appears to be an easy way out of difficulties, while at the same time no undue risk must be taken of a still-born baby and a damaged mother.

THE RESULTS OF CÆSAREAN SECTION

A collective investigation of Cæsarean sections performed by British surgeons in Great Britain and Ireland during the interval, 1911 to 1920, by Professor Munro Kerr

and Mr. Eardley Holland, has yielded information of the results of the operation of the greatest value. It is largely in the light of this investigation that we have been able to revise our indications and appreciate the importance and frequency of the complications and sequelæ.

The first group of cases considered is contracted pelvis. The analysis has been done with a view to ascertaining the variations in mortality of both mother and child according to the stage of labour and degree of infection present at the time of operation.

Excluding 30 cases of Cæsarean hysterectomy, the results are as follows :—

	Total cases.	Maternal deaths.	Mortality.
A. Not in labour . .	1,289	18	1·4%
B. Early in labour . .	384	7	1·8%
C. Late in labour . .	213	20	9·4%
D. After induction of labour	35	5	14·0%
E. After failure of forceps or craniotomy . .	102	27	26·5%

The following conclusions are drawn by Munro Kerr and Holland :—

1. The mortality of the deliberate operation (Class A) has fallen considerably when compared with Routh's series, 1900–9, in which it was double.

2. The mortality of the operation after fruitless attempts at forceps delivery remains as high as ever, largely due to sepsis.

Further, I may emphasise the fact that the risk steadily increases as the operation is done after the onset of labour, and that after the introduction of bougies or bags into the uterus the risk is ten times as great as in the deliberate operation.

In view of the fact that the justification for the operation late in labour and after "failed forceps" is to save the life of the child, it is interesting to note the fœtal results in the different categories :—

	No. of children.	Fœtal deaths.	Mortality.	Mortality of survivors.
A. Not in labour . .	1,208	10	0·8%	3·9%
B. Early in labour .	393	4	1·0%	5·0%
C. Late in labour . .	219	25	11·4%	5·0%
D. After induction .	(All fœtuses premature.)			
E. After attempts at forceps . . .	100	27	27·0%	10·9%

It will be noted that a high fœtal death rate follows the operation done late in labour, being more than ten times the rate of those done before or early in labour. Also, that nearly a third of all children to whom forceps have been applied are still-born and a further 11% do not leave the hospital alive ; in other words, in nearly half the operations done for a live baby after forceps application, the child does not survive and the mother has been subject to a great risk for nothing. In addition to the high rate of still-birth or neo-natal death, it must be remembered that many of the children have been injured by the severe and prolonged forceps operation.

Eclampsia.—The results of this investigation show a mortality of 32% of those cases treated by abdominal Cæsarean section, which agrees with the figures quoted elsewhere (see p. 116). Fifty per cent. of the children born were either still born or dead before leaving hospital.

Placenta Prævia.—I have already considered this condition in relation to Cæsarean section in detail (see p. 130). The mortality rates quoted by Kerr and Holland are as follows :—

	No.	Mortality.
1. Central or complete placenta prævia	78	14%
2. Incomplete (marginal or lateral) .	43	9·3%
3. " Placenta prævia " . . .	18	5·5%

It will be noted that the average mortality of Cæsarean section for placenta prævia done in British and Irish hospitals is not notably different from that of the vaginal methods of delivery at Queen Charlotte's Hospital for central and marginal cases (17·7%).

Accidental Hæmorrhage.—The question of the advisability of Cæsarean section or hysterectomy for this condition appears to receive a definite answer from the figures of Kerr and Holland, which I quote as follows :—

THE WHOLE GROUP

Operation.	No. of cases.	Deaths.	Mortality.
Cæsarean section .	36	4	11·0%
Cæsarean hysterectomy.	30	14	46·6%

It will be noted that the mortality of hysterectomy is about four times as great as simple Cæsarean section, which is not accounted for, in the opinion of the investigators, by the adoption of hysterectomy for more serious cases. In their opinion there was an equal distribution of the severest cases between the two operations. The fœtal mortality is 86%.

THE UTERINE SCAR OF CÆSAREAN SECTION IN SUBSEQUENT PREGNANCY AND LABOUR

The possibility of rupture of the scar of the uterus in a subsequent pregnancy of labour has been thoroughly considered by Eardley Holland (2), and his review goes to show that rupture of the scar is by no means a negligible contingency. It is well to bear in mind firstly, that perfect union of the cut uterine muscle can occur after proper suture,

Holland quotes Whitridge Williams's experience of microscopic examination of ten uterine scars some years after the original Cæsarean section. In eight of these the union of muscle was so complete that neither by the naked eye nor microscope could any trace of cicatrix be found except a slight vertical depression extending the length of the old wound on both the internal and external aspects of the uterus. Muscle fibres could be seen crossing the site of the scar without any fibrous tissue formation. In other words, complete organic and functional union had occurred.

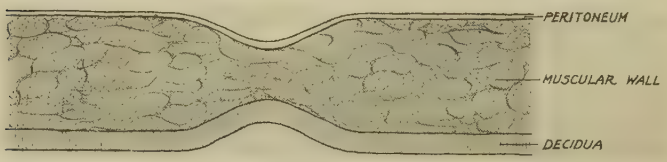

FIG. 9.—Imperfect muscular union.

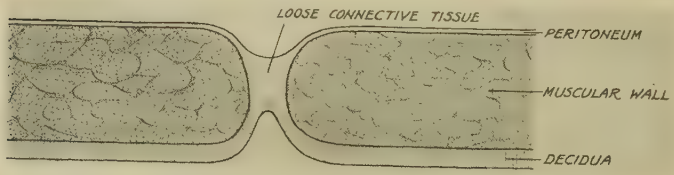

FIG. 10.—Absence of muscular union. Scar composed of peritoneum and decidua.

The characteristic of the imperfectly formed scar is its thinness at the expense of the muscle tissue. Only very rarely does the thin scar contain any muscle tissue beyond a few aberrant fibres scattered through a mass of fibrous tissue (Fig. 9). Three elements go to make up a thin scar : (*a*) The peritoneum, (*b*) the decidua, (*c*) a variable thickness of fibrous tissue intervening. In the thinnest scars there may be scarcely any fibrous tissue at all (Fig. 10), the peritoneum directly overlying the decidua. The retracted muscle is seen to be rounded and covered with decidua. As pregnancy

advances, the thin scar becomes progressively stretched and widened, tending to bulge like a herniated amnion, and it is quite obvious that such a deficiency in the uterine wall must be a source of great danger as the uterine tension increases.

When rupture takes place, it usually passes through one side of the thin area of the scar, and the muscle at the edges thickens and gives the appearance of the rupture having taken place through thick muscle (Fig. 11). Holland points out the importance of realising that the muscle edges are still covered by decidua, and are not in a condition to suture direct, without first denuding them of decidua in order to make raw areas. Repair of the rupture, if to be carried

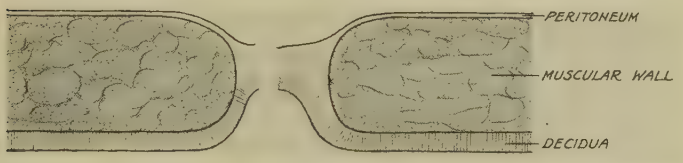

FIG. 11.—Rupture of scar.

out, should involve incision of the edges of the whole of the wound.

It is rare that a Cæsarean wound will give way during the convalescence following the operation. Several cases have been reported, however, generally due to the catgut knots employed having become spontaneously untied. If there is any element of sepsis present, it is almost certain that a fatal peritonitis would follow, but if the patient survives it is possible for the uterine wound to be sealed off by omental or parietal adhesions.

Adhesion to the abdominal wall in the presence of mild sepsis is liable to result in a utero-abdominal fistula, with constant discharge, menstrual and purulent, through the abdominal sinus. Abscesses in the utero-vesical pouch around infected sutures may develop, causing local acute abdominal symptoms.

Of the three possible sites of the scar, resulting from the transverse fundal incision, the classical and the cervical incisions, Holland produces evidence to show that the fundal scar is particularly liable to rupture. This is probably because the fundus bears relatively more distension than any other part of the uterus, and the incision passes at right angles to the direction of the bulk of the muscle fibres. The cervical incision has been followed by fewest subsequent ruptures, but the number of cervical incisions done is comparatively small, and the deductions based thereon are therefore liable to be fallacious. The relation of the placenta to the scar has much less influence than might be expected. It is certain that the Cæsarean incision heals as well whether it overlies the placental site or not, and in subsequent pregnancies the presence of the placenta does not cause liability to rupture by any eroding action. Of Holland's series of 51 cases of rupture in which details were stated, the placenta overlay the scar in 34, and had no relation thereto in 17. It would therefore appear that the placental attachment has some share in a subsequent rupture, due in Holland's opinion to a retro-placental hæmorrhage causing an increase of tension, which the attenuated scar was unable to bear.

CAUSES OF RUPTURE OF THE SCAR

1. **Sepsis.**—Of all the causes it is undoubted that infection of the uterine wound is the chief reason for its later weakness. For example, of 66 cases of ruptured scar, raised temperature or other form of uterine or abdominal sepsis was present in 51, while of the remaining 15 it is quite possible that a mild degree of sepsis occurred insufficient to raise the temperature but enough to prevent sound muscular union.

Severe sepsis will cause necrosis of the sutured edges, with infection of the silk and thread sutures, or rapid absorption of catgut with possible gaping of the uterine wound. Silk or thread will be discharged slowly, or remain as a permanent source of sinuses.

The milder sepsis will result in the formation of granulation tissue and a layer of fibrous tissue interfering with perfect muscular union. It is, therefore, most important to note the convalescence of a Cæsarean operation from the point of view of infection and fever before giving an opinion on the safety of another pregnancy and labour. In his review of ruptured scars, Holland states that a febrile convalescence almost certainly means a weak thin scar which will render a later pregnancy dangerous, while if convalescence has been afebrile, the risk of subsequent rupture is very small.

2. **The Suture Material.**—The uterine wound may be sutured with catgut, thread, silk, or silkworm gut. It is assumed that suture involves the whole thickness of the uterine muscle (excluding the decidua), which is an elementary necessity for a sound muscular scar.

Holland quotes details of 53 cases of ruptured uterine scars in which the suture material was specified. The figures are : catgut 41, silk in 12, and silkworm gut 0. At first sight it would appear that catgut is the least safe material, but it should be remembered that many more uteri are sewn up with catgut than silk or silkworm gut, and therefore, other things being equal, more ruptures are liable to be reported after catgut. It is true, however, that on theoretical grounds catgut and silk or thread are likely to be unsatisfactory. Catgut knots have been found untied at autopsy during the first week after Cæsarean section, and the increased autolytic powers of the involuting uterus would probably increase the rate of absorption of catgut. Moreover, if there is any infection present, catgut sutures would be still more quickly liquefied. In the case of the non-absorbable thread or silk sutures, we have a material which can maintain a persistent infection of the wound, with sinuses and fistulæ, should infection, however slight, have occurred at the operation. The greatest objection can be urged against silk and thread in the writer's opinion, because no

Cæsarean wound can be guaranteed sterile. In silkworm gut we have almost an ideal suture-material for the uterine muscle. It is non-absorbable, it is true, but it can be absolutely sterilised, is non-permeable, and cannot harbour organisms or maintain the presence of infection. It is non-irritating to the muscle tissue, results in a perfect scar, and so far has not been followed by rupture of the scar in any of the reported cases.

3. **Miscellaneous Factors.**—Other factors which predispose to rupture of the scar are over-distension of the uterus by fluid or twins, a prolonged and difficult labour, or the insertion of a hand or de Ribes' bag into the uterus. In fact, anything which adds any severe extra strain to the uterine wall may produce rupture of a weak scar, though it is certain that the perfectly healed scar can stand as much strain as any other part of the uterine wall. It sometimes happens that a normal pregnancy and labour may elapse between the operation and the delivery which produces the rupture, but in nearly all these cases there is some abnormal factor adding strain to the uterine walls during the delivery which causes the rupture.

The Period of Pregnancy at which Rupture Occurs

In 70 of the 87 cases in which the time of rupture was stated the accident occurred during the last four weeks of pregnancy, *i.e.*, at or just before full term. In a few cases a partial rupture had taken place earlier in pregnancy of such a nature as not to interfere with the continued retention and development of the ovum.

When rupture occurs in labour it usually happens early in the first stage.

Symptoms of Rupture

While rupture of the scar may be accompanied by the sudden acute pain and collapse due to intra-peritoneal hæmorrhage which is seen in ordinary cases of rupture of the

uterus, it frequently happens that rupture of the Cæsarean scar does not give rise to these serious symptoms. The tear takes place through a thin layer of decidua-peritoneum with very little, if any, muscular tissue, and no large vessels. Only if the placenta be implanted over the scar will there be serious intra-peritoneal hæmorrhage. It is probable that the rupture begins as a small perforation which becomes gradually extended until it is finally complete, allowing the baby to be born direct into the abdominal cavity, followed by the placenta.

The Frequency of Rupture of the Scar

It is not easy to arrive at a correct figure of the number of cases which suffered rupture of the scar in a subsequent pregnancy and labour owing to the difficulty of following up successfully.

Of the series of 1,103 cases of Cæsarean section followed up, 448 became pregnant again, progressed till term and were delivered either naturally or by a repeated operation.

Amongst these 448 cases there were 18 ruptured scars, which gives a gross percentage of 4. Further, the proportion of ruptured scars to successful deliveries is 1 to 4·3, which is a very high figure.

Considered from the point of view of suture material employed, it was found that after catgut the chance of rupture was 1 in 20, after silk 1 in 46·5, while after 21 cases of use of silkworm gut there was no case of rupture.

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Journ. Obsts. and Gyn. Brit. Emp., Winter, 1921.

CHAPTER VIII

PUERPERAL SEPSIS

Both professional and public attention have recently been attracted to the problem of puerperal sepsis on account of its outstanding importance in the matter of maternal mortality and morbidity. This latter subject I have dealt with elsewhere, chiefly from its public health aspect; in the present chapter I propose to deal with the clinical aspect of the ætiology, prevention, and treatment of puerperal sepsis.

The last Congress of British Obstetricians and Gynæcologists in London discussed puerperal sepsis on the basis of two statistical reports rendered by a Committee of the Obstetrical Section of the Royal Society of Medicine of which the writer was a member, and by the North of England Obstetrical and Gynæcological Society. The Congress also discussed other papers pertaining to the subject, particularly its bacteriological aspect, out of which emerged a certain amount of new matter. But on the whole, in spite of the vast amount of work which had gone to the preparation of the papers presented to the Congress, the amount of new information produced was comparatively small, and it cannot be said that our knowledge of this difficult problem has made any great advance in this direction, but the effort has been more than justified, if for nothing else than that it has exercised selective emphasis on knowledge we already possess, and has done something to focus the attention of all yet again on the chief cause of maternal deaths in child-birth. Further, it may be said that the lines of future work have been laid down with greater clearness, and it is to be hoped that when

next the matter comes up for full-dress discussion more new facts will have been learned.

Throughout this chapter the title " Puerperal Sepsis " is used to denote any septic condition of the generative tract following labour and occurring during the puerperium, the chief of which are localised perineal, cervical or uterine infections, or generalised blood infection (septicæmia).

Ætiology

The general causes of puerperal fever have been known for many years, but it is only recently that we have begun to realise the varying degrees of importance of all the different factors concerned, and the accurate study of the possibilities of autogenous infection has only just begun.

Again, while an enormous amount of investigation has been devoted to bacteriological problems, comparatively little work has been done on the resistances or susceptibilities of the patient to microbic attack, and that this must play an immense part in the development of puerperal fever is known only too well to all those who have the opportunities of clinical observation and are able to see one woman die and another escape with only mild symptoms even though the ætiological and bacteriological conditions of the two are apparently identical.

Further, the not infrequent occurrence of severe or fatal puerperal sepsis in a woman in whom no ordinary ætiological factor, such as difficult labour, can be traced compels us to realise that the ætiological problem is yet unsolved.

Broadly considered we find that any condition which is likely to sap the patient's resistance acts as a strong predisposing cause of sepsis by enabling organisms either introduced during labour or present in the genital canal before labour to multiply.

The commonest of these conditions are exhaustion in labour, due to mechanical difficulty, laceration of cervix,

vagina or perinæum (unsutured), and severe hæmorrhage in labour. Without the presence of virulent organisms, or those capable of developing virulence, mere exhaustion or laceration or hæmorrhage cannot, of course, cause puerperal sepsis, but it is probable that these microbes are so commonly in the vicinity, or implanted from without by the frequent manipulations which the difficult labour requires, that, in practice, sepsis does frequently follow exhaustion and damage.

To illustrate the foregoing remarks the results of the London Report on Puerperal Sepsis may be quoted. In 160 cases which recovered the labour was normal and spontaneous, without laceration or venereal discharge or any other obvious infection in forty-two, or 26%. In these cases there was no suggestion of any source of infection. In the remaining 118 cases, or 74%, there were varying degrees of interference, including forceps and version, and laceration and manual removal of the placenta, the latter accounting for 13% alone. Considering now the fatal cases of the series of 247, we find that eighty-seven died. Of these eighty-seven, labour was spontaneous, and normal in nineteen, or 22%. In the remaining sixty-eight cases there was interference, laceration, exhaustion, manual removal of placenta, or contact with other infection, the majority having suffered some form of interference during labour.

These facts expressed in tabular form are as follows:—

	No. of cases.	Interference, laceration.	Normal labour.
Recovered . .	160	74%	26%
Fatal . . .	87	78%	22%

Manual removal of the placenta has always been considered to be a dangerous procedure on account of the risk of infection. This is particularly liable to occur because the hand,

while removing the placenta, is applied directly to the open mouths of the large venous sinuses.

At Queen Charlotte's Hospital, where the operation is done with every possible care with the gloved hand and liberal use of antiseptics, of 199 patients from whom the placenta was removed manually, 42% had a febrile puerperium and 2% died. Too much attention should not be given to mere figures, for in these cases there were some patients who suffered difficult instrumental labour, which by itself was sufficient to produce puerperal sepsis, but in the majority there was nothing more than an adherent placenta after a normal labour, and it is proposed to regard the figure of 42% morbidity as being a fairly truthful index of the liability to contract uterine infection by this operation.

The London report gives an opportunity for regarding the matter from another angle. Out of 249 cases of puerperal sepsis the placenta was removed manually in thirty-four, of whom thirteen died (30%). Of the thirteen who died there was no other abnormality or interference in seven, or over 50%. Allowing for the unreliability of the statistical methods, there is, nevertheless, much evidence here to show that manual removal of the placenta carries a considerable risk of sepsis, and therefore should only be done when absolutely necessary.

Contact Infection

As a frequent cause of puerperal sepsis direct contact with infected patients has almost disappeared, but occasionally there are minor outbreaks in maternity wards. It is not easy to decide always whether a case of puerperal fever has been infected from other cases, but in the Report on Puerperal Sepsis there was strong evidence of contagion or direct transference of infection in fifteen out of 249 cases (6%). Compared with former days, when nearly every case was the result of direct transference of infection, this is a very small number.

The most striking fact about the reported "contact" cases was the subtlety of the means of infection. There was, apparently, no gross contamination, but it seemed that the presence of the infecting case within the radius of the ordinary traffic of the wards was sufficient to disseminate serious and fatal infection. As an example I quote a series of cases of contact infection from the London Report to illustrate how slight may be the actual contact.

Infecting Case.—Mrs. M. O. C. came into labour with pyrexia already developed, with a pleural effusion and superficial thrombosis of arms and legs. There were three rigors. Labour was normal and *no examination was made*. This patient recovered. The infected cases were :—

1. Normal labour, no streptococcus found in the blood—recovery.

2. Normal labour, one rigor, no streptococcus found in the blood—recovery.

3. Indirect contact with Mrs. M. O. C. for twenty-four hours. Normal labour. Hæmolytic streptococcus, no rigors, general peritonitis—died seventh day.

4. Indirect contact. Cæsarean section. Blood culture yielded hæmolytic streptococcus. No rigors—died on eighty-fourth day.

5. Normal labour. Hæmolytic streptococcus. No rigors, general peritonitis—died on the thirteenth day of the puerperium.

6. Easy normal labour, simple laceration of the perinæum, blood negative, no rigors, general peritonitis—died eleventh day of the puerperium.

The comment made by the obstetrician reporting this series is as follows :—

"All the above developed close together, having been confined with Mrs. M. O. C., who had ante-partum pyrexia. Not strictly isolated, but no connection between nurses examining the cases could be found, and no examination was made at any time of Mrs. M. O. C. But there was a certain

amount of common mixing during the actual labours of the six secondary cases, extending over periods of from twelve to twenty-four hours, after which the cases were removed to separate wards.''

The ordinarily accepted view is that contact cases are of exceptional severity, dying within a few days of a fulminating form of the disease, but of the fifteen cases reported only five died, which is a mortality of 33% against 36% for the whole series.

Other Ætiological Factors

1. **Induction of Labour.**—It is well known that induction of labour by bougies or small rubber bags under surgical conditions is a remarkably safe operation from the point of view of sepsis. In spite of the introduction of foreign bodies into the uterus between the membranes and uterine wall for a period of about three days, serious infection rarely occurs. At Queen Charlotte's Hospital, of 582 consecutive cases of induction of labour by bougies or introduction of bags, there was a morbidity rate of 15%, and one patient only died of sepsis, giving a mortality of 0·17%. There is here very definite evidence of increased risk of a mild form of sepsis when labour is induced, but the rate of mortality is no greater than that from sepsis quoted in the Registrar-General's returns. The London Report on Puerperal Sepsis mentions nine cases of induced labour out of a total of 247 cases of sepsis, and of these six died.

2. **Albuminuria.** Considering the same series of 247 cases of sepsis there were fourteen which were noted as having albuminuria, and of these five died, but of the five fatal cases, three suffered from other conditions of much greater importance in the production of sepsis than albuminuria. It does not appear from this report that albuminuria plays any great part in the causation of sepsis, and in support of this the London Report on Eclampsia states that out of eighty fatal cases of eclampsia, only one died of sepsis.

3. **Exploration of the Uterus.**—It has been long felt by those engaged wholly in the practice of obstetrics that exploration of the puerperal uterus either before fever has begun or after its onset, as a therapeutic measure, is a highly dangerous and seldom necessary procedure. It is widely believed and still taught that the chief cause of puerperal sepsis is the presence in the uterus of fragments of retained placenta or chorion, and that when once a lying-in woman shows signs of uterine infection it is imperative "to clear out" the uterus as soon as possible. Of recent years, however, it has been gradually accepted by obstetricians who have the opportunity of seeing many of these cases that digital or instrumental exploration of the uterus after labour should be carried out only under a few definite indications, and that of these indications uncomplicated sepsis is not one. This opinion is founded upon the clinical experience of the result of exploring the septic uterus, and the comparatively few occasions on which exploration yields any of the retained fragments which are supposed to exert so malign an effect on the patient, together with the experience of analogous surgical conditions in other parts of the body, where it is well known that stirring up the inflamed parts leads to an immediate exacerbation of septic intoxication. The puerperal uterus, however, is a particularly unsuitable part for the trauma of exploration when in an infected condition. It is a large raw area, and the recently thrombosed venous sinuses still offer easy portals of entry for organisms to travel directly into the larger veins of the pelvis, should there be the least disturbance of the overlying clot. In addition, we are dealing with a patient whose general resistance to microbic invasion appears to be decidedly below that of the non-puerperal individual. Looking at the problem from another angle, it is right to ask what good exploration of the uterus might be calculated to do. It is usually carried out under the impression that a septic uterus, *ipso facto*, must contain fragments of retained placenta, and that such retained putrid fragments are the

cause of dangerous symptoms. But, considering the undoubted danger of exploration of the septic uterus, it is proper first to ask what are the chances of retention of placenta, what are, if any, the certain symptoms of placental retention, and the risks of leaving it *in situ*, and what improvement may be expected to follow the removal of such fragments.

(*a*) The frequency of retention of a cotyledon of placenta within the uterus after labour is extremely small. In Queen Charlotte's Hospital it occurs two or three times a year out of about 3,500 labours. When it does occur it is usually a placenta succenturiata or a fragment left by the breaking up of an adherent placenta during manual removal. After normal labour, as far as delivery of the placenta is concerned, and where hæmorrhage after labour has been within normal limits, the retention of a placental fragment is extremely rare, much rarer than the incidence of sepsis.

(*b*) The chief symptom of placental retention is puerperal hæmorrhage. It cannot be emphasised too strongly that sepsis is an incident only, due, not to the retention of placenta within the uterine cavity—for it has been seen after many weeks' retention in an uninfected condition—but to the infection of the fragment by organisms introduced from without. Further, the presence of placenta has no influence on the *variety of organism* which infects, and this is the all-important feature from the clinical point of view. If hæmolytic streptococci gain access to the uterus the infection will be a severe one whether placenta is present or not, while if the organisms are of the harmless putrefactive variety the presence of dead tissue will do no more than prolong the time of illness. They cannot increase the virulence or convert saprophytic microbes into a dangerous pyogenic variety. The whole point is the nature of the organism, and not the presence of necrotic tissue.

Retention of placenta is, however, important, not because of its liability to cause dangerous sepsis, but because of the certainty of *puerperal hæmorrhage*. Hæmorrhage from this

cause is usually free after labour, the uterus may not contract well, and the lochial discharge will contain more blood than normal. But the characteristic feature is a recurrence of hæmorrhages during the puerperium of increasing severity until the patient will become blanched and may die unless attended to. The first hæmorrhage usually occurs within the first week, and is quickly followed by other attacks of bleeding. This is particularly liable to occur on first getting up, but care should be taken not to mistake the frequent return of a little stained lochial discharge for a placental hæmorrhage. A second symptom is probably a putrefactive discharge, but this is not necessarily due to a piece of placenta. It is a not uncommon symptom and is nearly always caused by fragments of necrotic chorion. The diagnosis between the two is usually easy by noting the persistence of putrid lochia. Chorion, being a thin membrane, soon disintegrates and comes away naturally if the patient is drained by being well propped up, when the offensive odour of the discharge will at once cease, but placental fragments are comparatively massive pieces of tissue which persist within the uterus for a long time, thus maintaining an offensive discharge for a much longer period than in the case of retained chorion. Further, retained chorion does not cause free hæmorrhages, but nothing more than increased redness of the lochia.

(*c*) The risk of leaving placental tissue within the uterus is mainly hæmorrhage. There may, or may not, be putrefaction, but hæmorrhage sooner or later is almost bound to occur, and it is emphatically bleeding rather than sepsis which is the pressing danger. Simple putrefactive infection does not involve the patient in actual danger, while, as we have already pointed out, if hæmolytic streptococci are present the patient is in considerable danger whether placenta is present or not.

(*d*) If placenta is retained it must be removed, and as soon as possible. Simple putrid discharge will cease almost at once, and if this is the only form of infection present, then

there will be a rapid clinical improvement. The danger from hæmorrhage also will cease at once after removal of a retained fragment.

If, therefore, unnecessary exploration of the uterus must be avoided as being highly dangerous and liable to set up infection, or cause a secondary septicæmia from a localised uterine infection, it is imperative to know when the operation should be carried out, *i.e.*, to know when placenta is retained. I feel strongly that sepsis itself must not be regarded as an indication. Hæmorrhage beyond the lochial amount is a sufficient indication and demands an examination, first through a vaginal speculum to exclude the possibility of secondary hæmorrhage from cervical or vaginal tears, and then, in the absence of these, digital exploration of the uterine cavity, under an anæsthetic, as carefully as possible.

A prolonged putrefactive discharge, *i.e.*, one which does not clear up in ten days with the patient well propped up, may also mean a retained fragment of necrotic placenta, though it is possible that even here it may proceed from a large sloughing wound of the cervix and vaginal vault. In the absence of bleeding I am inclined to leave alone such a condition unless adherent placenta at labour with manual removal suggests that placenta could have been retained.

Turning again to the ætiological importance of placental retention, I believe that it is immaterial in determining the existence of severe puerperal sepsis inasmuch as this depends upon the invading organism, though it is true that it does maintain putrefactive discharge. A more important question is the likelihood of intensifying puerperal fever by unwise and unnecessary exploration. Curettage of the septic uterus, even by the blunt curette, is so highly dangerous in disseminating infection that it is now rejected by everybody. The only permissible method is by the finger, working as slowly and gently as possible.

It is impossible to extract reliable information from the case-histories submitted to the London Committee, but such

as they are may be quoted. Exploration of the uterus was carried out in fifteen cases out of a total of 249—a small number considering the general prevalence of the operation. Of the fifteen cases, twelve were fatal, a strikingly high mortality when compared with that of the whole series, which was 36%. It is clear that, whatever else may be said, the chances of life were not improved, and therefore that this operation has little place as a remedial measure for sepsis.

4. **Hæmorrhage in Labour.**—It is well known that serious hæmorrhage plays an important part in lowering a patient's resistance, and will therefore favour the incidence of puerperal sepsis if other ætiological factors have already operated, such as difficult manipulative labour. In many cases, however, of sepsis following hæmorrhage in labour there have been no other conditions present which might have introduced sepsis. In these cases we have examples of the importance of the "soil" rather than of the nature and virulence of the organisms implanted thereon.

Presumably the infection here is a mild autogenous organism, or some semi-virulent microbe introduced from without, which would have little or no effect on a woman of normal resistance and vitality, but is able to establish itself and develop its virulence in the presence of a feeble resistance. Cases of puerperal sepsis following hæmorrhage offer particularly good examples for the further study of this disease.

The London Committee report that there was an incidence of 8% of the whole series who had had pathological hæmorrhage, and of the total of twenty cases thirteen died, which is a mortality of 65%.

Autogenous Infection

While exogenous infection in puerperal fever is of paramount importance and requires all possible care for its preven-

tion, there remains a by no means negligible residue (some 25% of the present series) of cases in which it is difficult to trace the existence of infection introduced from without. This type of patient is illustrated by the woman who has had a normal unassisted labour, perhaps with no internal examination during labour, and yet in spite of no interference, develops a severe and perhaps fatal form of uterine sepsis. Such cases are within the experience of most people who have carried on obstetric practice, and in the light of present teaching of the causes of puerperal fever are a constant source of amazement and anxiety. The accumulation of these experiences by all engaged in active obstetric practice has led irresistibly to the view that a certain proportion of cases are infected from within and not from without. There has been a certain amount of reluctance to endorse this view as anything like a frequent cause of sepsis by a section of obstetricians, particularly those engaged in teaching, for it is feared that the acceptance of so easy and only partially supported a theory might tend to a lessening of the rigidity of antiseptic and aseptic precautions in labour, and a relaxation of care in the conduct of midwifery. But so long as a full emphasis is rightly laid upon the frequency and dangers of exogenous infection and methods of preventing it as learnt from a study of its ætiology, there can be nothing but good arising from the investigation and subsequent teaching, after establishment, of the frequency, nature, means, and prevention of autogenous infection. Much work has been done recently to try to prove the existence of a potentially virulent organism within the genital passages, or even other parts of the body, before labour, and to identify the same microbe as the cause of a subsequent attack of sepsis after labour. But though it may be possible to establish the existence of the organism before labour much more study of the "soil," *i.e.*, the patient and her resistance is necessary, to explain the absence of clinical infection in some women and the development of it in others who have had a similarly normal labour.

We know little yet about the alteration in the killing power of the blood and tissue fluids which probably takes place immediately after labour. That some great alteration or reduction in resistance does occur seems probable, judging from purely clinical observation, but it is necessary for this unsupported clinical surmise to be substantiated and defined by some exact serological investigation. Work on these lines is at present being carried out in the Inoculation Department of St. Mary's Hospital, and will presently be published. Meanwhile, Bigger and Fitzgibbon (1) have investigated the bacteriological condition of the uterus and vagina before and after labour, and in common with other workers have proved the existence of potentially virulent organisms in the vagina and cervix before labour. Bigger and Fitzgibbon at the Rotunda Hospital of Dublin examined 158 swabs taken from the posterior vaginal fornix, the cervix before labour, and the vagina and uterus after delivery. The cultures were made in fluid media in order, as the observers explain, to ascertain if any streptococci were present at all, disregarding the question of the numbers present. The primary cultures were then sub-cultured and later classified by carbohydrate media. Every care was taken by their technique to make cultures quickly after securing the specimen to avoid drying of the swab and death of the organisms. The women were examined either before or just after the commencement of labour, and during the puerperium between the second and seventh days. Their gross results are as follows :—

Number of patients	50
Number of swabs	158
Streptococci absent	57
Streptococci present	101
Streptococci found	104
Strep. fæcalis	43
Strep. mitis	42
Strep. equinus	10
Strep. salivarius	7
Strep. equi	1
Strep. infrequens	1

Of these, only two, *i.e.*, *strep. equi* and *strep. infrequens*, were hæmolytic. All the others were non-hæmolytic and, therefore, probably saprophytic in nature. Neither of the hæmolytic organisms was identified with *strep. pyogenes*, which is the common cause of puerperal septicæmia. The noteworthy feature of the above table is the comparative rarity of the hæmolytic organism.

The following table shows a comparison of organisms found before delivery and after delivery :—

	Before delivery.	After delivery.	
	Vagina.	Vagina.	Uterus.
Number of swabs . .	58	50	50
Streptococci absent . .	26	8	23
Streptococci present . .	32	42	27
Strep. fæcalis . . .	16	16	10
Strep. mitis . . .	10	20	13
Strep. equinus . .	5	3	2
Strep. salivarius . .	3	2	2
Strep. equi . . .	0	1	0
Strep. infrequens . .	—	1	—

From this table we see that twenty-seven out of fifty uterine swabs were positive, or in 54% of cases streptococci passed from the vagina to the uterus after delivery. But they were non-hæmolytic streptococci and of these patients only two developed temperatures with uterine infection. Therefore, it is quite obvious that non-hæmolytic streptococci at any rate can exist in the puerperal uterus without causing symptoms.

A further series of puerperal uterine swabs taken by a different technique and with redoubled care to avoid cervical or vaginal contamination, showed that 20% of the patients had uterine infection by streptococci, all without any clinical

symptoms of infection. Other conclusions drawn by Bigger and Fitzgibbon from their work are :—

" 1. The commonest form of puerperal sepsis, that caused by hæmolytic streptococci (and particularly *strep. pyogenes*) is due to exogenous infection.

" 2. Non-hæmolytic streptococci do occasionally cause puerperal sepsis. These organisms are present in the majority of parturient women and are found fairly frequently in the uterus post-partum. They are normal body saprophytes, but are opportunists as regards pathogenicity. (The *strep. fæcales* may give rise to suppuration in wounds, and the *strep. mitis* to septicæmia and subacute endocarditis.)

" The cause is the streptococci of the vagina plus some unknown factor, which may be a local or general lowering of the patient's resistance or a rapidly enhanced virulence of the organism."

This important problem has also been investigated by Lockhart at St. Thomas' Hospital.(2) He set out to determine the occurrence of streptococci before and after delivery (with clinical examination) and the relation of these findings to the development of puerperal fever. One hundred consecutive women were examined, swabs being taken from the external os, immediately after admission, at once after delivery, and during the puerperium if the temperature rose to about 99°. The general results are as follows :—

BEFORE LABOUR

Number of women examined . .	100
Infected	48
Not infected	52

The relation to puerperal pyrexia :—

INFECTED.		NOT INFECTED.	
Pyrexia.	No pyrexia.	Pyrexia.	No pyrexia.
9	39	1	51
= 19%	= 81%	= 2%	= 98%

We see from these figures that about half of each group of

labours was infected before labour began by streptococci resident in the external os and vagina, but that in the case of interference to assist labour, or of perineal and vaginal damage, the rate of definite puerperal sepsis was nearly three times as great as in normal labour. This observation in bacteriological and clinical evidence still further supports the contentions in Chapter II., that one of the most potent causes of puerperal sepsis is interference and damage during labour, and further, that such sepsis is still more liable if vaginal infection by streptococci has existed before labour.

All workers are agreed that the hæmolytic streptococcus is a far more dangerous organism than the non-hæmolytic variety, and is much less commonly found in these cases in the cervix after delivery. How far the one type can metamorphose into the other type is difficult to state finally, but there is evidence that some varieties, at any rate, of the non-hæmolytic type may develop hæmolytic properties under a suitable environment.

A secondary problem is the explanation of how streptococci gain entrance to the vagina before delivery. It is probable that in most women who have gonorrhœa the streptococcus is present as an ordinary secondary infection which is so commonly, if not universally, found in all cases of chronic gonorrhœa, while in multiparæ who have had previous cervical lacerations the organism is accounted for by the consequent cervical catarrh. A study of the organisms of leukorrhœa shows streptococci to be present very frequently, mixed with other microbes, but occasionally present in pure culture. Lockhart, in his paper, considers the possibility of coitus late in pregnancy as a means of introducing the infection, and gives the following figures :—

Of sixty-one women who gave definite information, 31 % had had coitus within seven days of labour. Of these who were infected with streptococci before labour the mean average time since the last coitus was thirty-two days, while

of those with no infection before labour, the mean average time was sixty days or nearly twice as long.

From these general observations it does appear that late coitus has an influence on the infection of the vagina and therefore increases the liability to subsequent puerperal sepsis.

Summing up the possibility and importance of autogenous infection we have the indisputable clinical evidence of puerperal fever of the worst forms developing after perfectly normal labour without interference or damage, and, occasionally, without even vaginal examination. Secondly, there is the bacteriological evidence that many women have a vaginal streptococcus before labour, and that in a few cases the organism is of the hæmolytic type. But there is not the clear sequence of pyrexia following the labours of all who have vaginal infections which one would expect if the organism itself were the chief or only element of importance. In many there is no fever, even when streptococci are present, and this observation is sufficiently obtrusive to force our attention still further to the other element in the system, namely, the "soil" on which the microbe is planted. We need further information on the resistance of the woman during the early puerperium and the local immunity developed against the autogenous organism. If it can be proved that delivery is followed by a negative phase of resistance then it is theoretically possible that not only vaginal organisms but others infecting other chronic foci of the body, such as the teeth, fæces, urine, throat, etc., may, in the presence of a diminished resistance after labour, suddenly develop increased virulence and spread rapidly into the blood stream. In these cases they would automatically be poured out into the uterine cavity and so give the impression of a uterine infection by the ordinary bacteriological examination of the uterus. It is the writer's opinion that strong clinical evidence exists to support the theory of the generalisation of infection from localised non-genital foci immediately after

labour, but not until the bacteriological power of the blood before and after labour is fully worked out can we have much exact knowledge for summing up the place of autogenous infection in the production of puerperal sepsis.

Clinical Features

An analysis of the case histories of 249 patients yields information on certain clinical features which are chiefly interesting from the prognostic point of view. The weak points in any analysis of this kind are that case reports are seldom sufficiently full of information to enable comparisons to be made satisfactorily, and secondly, the statistical form of expression must be utilised to convey such information as may be extracted from the analysis.

In spite of these drawbacks, however, certain points of clinical interest have emerged either confirming what has already been known, or tending to modify generally accepted ideas.

1. **Onset of Pyrexia.**—In 83% of 230 cases the fever began during the first five days, but as the following table shows, it can occur at any time during the puerperium—

Day . . .	0	1st	2nd	3rd	4th	5th	6th
Number of cases .	8	20	39	59	49	15	11

Day . . .	7th	8th	9th	10th	12th	13th	16th
Number of cases .	7	7	1	8	3	1	2

It is noteworthy that so many as eight developed the first pyrexia on the day of the labour, of which 50% died. When the onset is so early it is usually caused by a very prolonged

and exhausting labour in which the membranes ruptured at the beginning thus providing a definite incubation period before delivery, or else it indicates some form of infected interference, such as induction of labour.

The relation of the onset of pyrexia to mortality is seen by the following table, where the percentage death rate is set under the day of onset :—

Day of onset	0	1st	2nd	3rd	4th	5th	6th
Mortality .	50%	66%	36%	37%	35%	26%	27%

It will be noticed that the day of labour and the first day after labour are particularly dangerous for the onset of fever, while the risk on the third and fourth days is almost identical. In the same way the mortality of the fifth and sixth days is the same, but is appreciably lower than that of the preceding days.

2. **Degree of Pyrexia.**—It is within the clinical experience of all that there is little prognostic value in the height of the temperature in puerperal fever. The puerperium is a time of unstable temperature, when a trifling condition is liable to produce an alarming fever. In the analysis under consideration the average highest temperature of those that recovered was 103·3° F., which shows, as far as figures can show anything, that the actual highest temperature attained is of no prognostic value whatever.

The type of pyrexia is of more value in prognosis than the height. Persistence of high fever without remissions is much more serious than remittent fever.

3. **Pulse Rate.**—The frequency of the pulse is of much more clinical value than the degree of pyrexia as a guide to prognosis.

The appended table illustrates well that the pulse rate gives a useful idea of the toxicity of the patient.

Pulse rate.	Mortality.
110 and under	4%
111 to 120	21%
121 to 130	40%
131 to 140	42%
141 to 150	71%
151 and above	83%

If the pulse is maintained, therefore, below under 110 the mortality risk is very small.

4. **Rigors.**—The information furnished by the report on the incidence of rigors was unexpected. It is usually believed that the presence of rigors indicates a much more serious state of affairs than when they are absent, but in our inquiry we found that the mortality was actually greater when no rigors were present. Further, the number of rigors had little, if any, value as a prognostic indication.

Out of 205 cases observed in institutions by trained nurses, 58% had rigors, and in 42% there were no rigors. The mortality was as follows :—

Rigors.	No. of cases.	Mortality.
None	87	40%
One rigor	42	36%
Two rigors	15	13%
Frequent	61	38%

It will be noted that there is little difference between the mortality rates with the exception of those having two rigors. Here there is an obvious fallacy, probably accounted for by the comparatively small number of cases.

Little can be gained by examining the prognostic importance of the onset of the first rigor except the general observation that in fatal cases the rigor tends to occur immediately after the onset of the fever.

5. **Blood Cultures.**—The results of blood culture in any case history reports must be taken with considerable reservation where a negative result is returned unless we know that the blood has been collected at the proper time and has been repeatedly examined if the first observations are negative.

It is in very few cases that sufficient care has been exercised to render them of investigatory value, where the result was negative, but positive observations with streptococci found are cases which can be profitably studied. Out of 136 cases examined the blood contained streptococci in fifty-three and *Bacillus coli* in four, while in seventy-nine no organism was grown.

The mortality was as follows :—

Seventy-nine negative cases .	20%
Fifty-three streptococcal cases .	66%

The most striking feature of the study of the blood positive cases is the occurrence of rigors. Of the fifty-three streptococcal cases 38% had no rigors, and of these 80% died.

There is, therefore, a very different outlook according to whether streptococci are found in the blood, the risk in the positive cases being more than three times as great. It is also noteworthy that as many as 34% of blood-positive cases recovered.

Treatment

In spite of the great volume of time and labour that has been devoted to the study of puerperal sepsis it is unfortunately true that very little real progress can be recorded in the department of treatment. The reasons for this failure are diverse, but each year by its small contribution of exact knowledge brings nearer the time when we hope to have command over the disease. At the present stage it is still right to emphasise again the paramount importance of prophylaxis. In previous sections of this work I have fully considered the necessity and possibilities

of prevention. In proportion as the disease can be prevented so does the problem of curative treatment become of less relative importance, but, inasmuch as there will always be an irreducible minimum of puerperal fever, however perfect be the prophylaxis, therapeutics will always be required.

The reason for comparative lack of progress is the innate difficulty of the problem. Though the processes of infection and resistance are largely known, the control of the generalised blood infection still baffles us. In many cases we are dealing with an infection of such virulence and a patient of such prostration that the natural resistance, on which all therapeutics relies, is of no effect, and no treatment could hope to be successful short of direct and complete slaughter of the infecting microbe by the therapeutic agent. This is a novel idea in therapeutics, and in no other branch of medicine can it be practised, as all treatment really takes the form of development of the patient's own natural resisting powers. But the majority of cases of puerperal septicæmia are not of this fulminating character, and their life after infection is sufficiently prolonged to indicate that the resistance is putting up a brave fight, and merely requires efficient help to enable it finally to prevail. A further difficulty in arriving at any true idea of the value of various forms of treatment already practised is their very multiplicity and combinations in any one patient studied. The attempt by the London Committee to form an opinion on this point failed because of this difficulty. It is impossible in clinical practice to adopt experimental segregation of methods in sufficient numbers of cases to render results of scientific value. Moreover, the clinical conditions and varieties of individual cases differ so widely that comparisons cannot be made on common bases, even when one particular line of treatment has been adopted. The result of attempts at this form of investigation is that little more than *impressions* can be gained by any one observer, which may be at variance with those received by another equally exact

worker. The difficulties of estimating the effects of treatment are further increased by the well known capriciousness of the disease itself. How many times has a patient suffering from what is a severe form of uterine infection suddenly recovered herself with little or no treatment that could be described as of direct therapeutic value, while another, apparently similar, case may, in spite of every resource of treatment and nursing, steadily go downhill and finally succumb! Long experience of puerperal sepsis may easily encourage the somewhat cynical view that the patient's progress either towards recovery or a fatal issue is not within our control no matter what treatment is adopted! While there may be some justification for this attitude towards the more so-called scientific methods there is none in respect of the older and simpler methods exemplified by good nursing and treatment of distressing and exhausting symptoms. While there is no agreement on the value for example, of serum therapy, all with experience must have been impressed by the improvement effected by removal from an ill-equipped little home to an institution where efficient nursing and symptomatic treatment could be adopted.

Before any discussion on direct or scientific methods it is well at the outset to state emphatically that in the present unsettled state of our knowledge and opinions of these methods, the most solid advantage will be derived by nursing and simple medicinal treatment. If by these means comfort can be given, or, perhaps in scientific language, the patient's resistance can be encouraged by cutting off exhausting conditions, the chance of recovery will be considerably improved. For example, a well nursed patient will be propped up in a position which allows of sufficient drainage of the uterus, one of the most important of all principles in the treatment of any septic condition, instead of lying flat, or slipping down in the bed from off an insufficient number of useless pillows. A good nurse will further see that discharges are not allowed to accumulate at the vulva, that the bowels are opened when

necessary, that the mouth is cleaned, that feeding is rational and regular, and that tepid sponging is done for high temperatures. Many other things will be noted by a good nurse and duly reported to the doctor. In short, a nurse can do so much to make the patient comfortable and report symptoms and other developments. Similarly, the doctor, by treating symptoms such as insomnia, diarrhœa, pain, vomiting, etc., can do much to save exhaustion and so increase the natural resistance.

In seeking for and testing new scientific remedies designed for direct attack on the infection, it must not be forgotten that any method will have a greatly increased chance of cure if it is reinforced by all the resources of good nursing and "doctoring."

As an illustration of the multiplicity of methods of treatment which are adopted, the London Committee found that in their series of 249 cases there were no less than sixty different methods or combinations of methods. Any attempt to carry out an analysis of the results and efficacy of any one line was obviously futile. Some of the methods described were: "general medical," "postural," douching, antistreptococcal serum, vaccines, stock and autogenous, collosal iodine, collosal argentum, transfusion of blood, immuni-transfusion, saline solution, sodium bicarbonate per rectum and intravenously, quinine intramuscularly and intravenously, phylacogen, anti-diphtheritic serum, *Bacillus coli* serum, ensol intravenously, irrigation of the uterine cavity with methyl violet and brilliant green, and intravenous injections of mercurosol and perchloride of mercury. This long list, coupled with the high mortality of the series, is eloquent testimony that the remedy is yet to be found.

Considering now modern methods of direct treatment, we find that they fall into two classes, firstly, those that aim at direct destruction of the organism *in vivo*; secondly, those that aim at increasing the killing power of the patient's blood.

The more we learn of the action of antiseptics, not only on the microbe but also on the tissue cells and fluids, the more we realise that direct action on the microbe can be of little value when it is free within the blood stream or buried in tissues. The principle of direct bactericidal action was the first that appealed to clinicians, for it seemed to be the logical outcome of the discovery of antiseptics, but laboratory work has shown the overwhelming difficulties that attend the application of this principle *in vivo*, and clinical experience cannot furnish any reliable evidence of its therapeutic value. Any improvements that may have been observed are probably due to the action of the chemical agent facilitating natural bactericidal powers rather than directly killing the organism. Since the action of antiseptics has been more thoroughly understood and Wright's work on the resistance of the blood, attention has been concentrated on the second line of attack, that is by aiming at increasing the potency of these natural resistances.

I. Direct Treatment of the Uterus

The uterine origin of most forms of puerperal sepsis has naturally directed attention to the uterus for the purposes of treatment, and all degrees of uterine treatment have been practised from complete hysterectomy to entire neglect of all local treatment whatever. While it is an easy matter to set forth the present view of local treatment it is probable that the succeeding years will see modifications of existing practice, for as yet there is no undisputed standardisation. Specific treatment of all kinds, both local and general, must wait upon the guidance of the bacteriologists and serologists, following their advances in knowledge step by step.

1. **Hysterectomy, Ligature of Pelvic Veins, etc.**—Radical removal of the septic focus, in this case the uterus, might be expected to rid the patient of her infection in severe puerperal sepsis, but against the easy logic of this reasoning there

are many serious drawbacks. The operation has been seriously advocated, and has been carried out, but there seems no prospect of its general adoption. The first obvious difficulty is that, to be effective, the uterus should be removed at an early stage of the disease, *i.e.*, before the patient has become deeply intoxicated and while she would be able to tolerate an abdominal operation without undue risk. But it is precisely in this early stage that the disease is so often indeterminate. As we have already noted, patients with an apparently serious onset, which at first sight might legitimately be suitable subjects for hysterectomy, make rapid and spontaneous recoveries, while others, whose onset is mild and gradual, may slowly slip downhill and be beyond the help of operation before the gravity of the case is sufficiently realised. Apart, however, from the great difficulty of decision of the proper cases for operation, the results of hysterectomy are very bad and do not promise success along radical lines. Ligature of the pelvic veins, *i.e.*, the ovarian veins and such veins in the broad ligament as can be reached, has been carried out for certain severe forms of puerperal sepsis, particularly so-called pyæmia, with repeated and frequent rigors and septic thrombosis of the veins draining the uterus. The aim of this operation is to tie the veins high up above the thrombus formation to prevent further detachment of septic particles and escape into the general circulation. From the writer's own observations it appears necessary to ligature the right ovarian vein as high up as possible, *i.e.*, just at its point of entry into the vena cava behind the duodenum, while the left vein should be tied at its point of entry into the left renal vein. In addition, the uterine veins should be tied as near to the internal iliac veins as possible, and a drainage tube should be left in the pouch of Douglas. This is also a very serious operation to carry out on a patient so ill as they are with pyæmia, and it is attended by so high a mortality as to render it almost unjustifiable in its present form. The writer's experience of one case was that daily and

frequent rigors ceased completely for five days after the operation together with a marked drop in the temperature, but they recurred after this interval with death following in a few days. At autopsy it was noted that the ligature on the right ovarian vein at its junction with the vena cava had effectually prevented the upward extension of clot, but on the left side thrombosis had extended above the ligature which had been applied only at the brim of the pelvis. If it had been made at the junction with the renal vein it is possible that thrombus formation would not have extended beyond it.

2. **Irrigation and Disinfection of the Uterine Cavity.**—Stress has already been laid upon the great danger that attends exploration of the uterus in a septic condition, unless there is a gross amount of material to be removed, such as a fragment of placenta or sloughing fibroid. The gentle introduction of an irrigation tube, however, does not damage the uterine cavity anything like the same extent as digital exploration or curettage, and it is a means for irrigation which may prove to be of real value in dealing with uterine infections. It is, however, of great importance to understand clearly the comparative values of local disinfection and local irrigation. The former is a method which aims at direct slaughter of the microbes contained within the uterine cavity and within reach of the antiseptic fluid. It is obvious that only those superficially placed can be acted upon, for those buried in the uterine wall are beyond the radius of action of any antiseptic douche. As we shall point out in a later section the action of any antiseptic fluid on the tissue cells has to be considered in addition to its action on the organism. The defence of the patient must rely almost entirely upon her own natural resistances, and if an antiseptic douche while killing possibly a minute number of the invading host at the same time damages the leukocytic defence in the uterine wall, then it is of very doubtful value. Indeed, we can go further and say that inasmuch as the deeper organisms are

not touched, antiseptic douches in sufficient strength to kill the superficial microbes will also damage the uterine wall and therefore do more harm than good.

If, however, the irrigating fluid is chosen with a view, not of directly killing microbes, but of promoting a flow of bactericidal lymph through the uterine wall into its cavity, we shall bring into operation a mechanism that will kill microbes without at the same time damaging the uterine tissues, and will operate upon those buried in the uterine wall as well as those lying upon the surface of its cavity. This theory has been practised by Remington Hobbs during the last few years with great success. While I am not able to go quite so far as Hobbs in his claims, I acknowledge that his work is of great value and promise. His method is the injection of glycerine into the uterine cavity through a soft rubber tube carefully introduced by the aid of a speculum. The frequency of the injections depends upon the acuteness of the infection, but can be carried out as often as desired. The ideal method is to have a rubber tube permanently *in situ* through which a nurse may inject the glycerine without disturbing the patient. Glycerine is a harmless non-irritating fluid which is powerfully hygroscopic and therefore is able to abstract lymph from the uterine wall into its cavity. A flow of bactericidal fluid is thus produced which has a pronounced effect on the infection as judged by clinical results.

It is obvious that the success of the treatment depends ultimately upon the bactericidal properties of the lymph flow that is set up. In heavy infections this may be very greatly reduced, and, therefore, the complementary treatment must be measures which can increase the bactericidal power of the body fluids. This aspect of treatment will be considered in a later section. Suffice it to say here that the best methods of treatment at present at our disposal are firstly, to improve the bactericidal powers of the blood and lymph, and secondly, to promote a free flow of this lymph through the uterine cavity to deal with the focus of infection.

II. Antiseptic Methods

Before we can recommend any particular antiseptic for injection, either intravenously or intramuscularly, it is necessary to have knowledge of the action of the material upon the blood cells. Even though it may kill microbes in great dilutions, we must know firstly whether it can kill them when bathed with tissue fluids, and secondly, whether its action on the tissue cells is not even more destructive than on the organism. The problem has been considered by A. Fleming.

The discussion of the mode of action of antiseptics in the blood, though of general medical interest, can be justifiably introduced into a work on puerperal sepsis, a condition which has been treated for some years on these lines.

Fleming used the staphylococcus for his investigations as it was a convenient organism. The blood fluids exert no bactericidal power against this microbe, but the whole blood, *i.e.*, blood fluids plus leukocytes, has a powerful lethal effect. Experiment easily and clearly shows this action to be due to the leukocytes. Fleming's first observation is that "*carbolic acid in a concentration of* 1 *in* 400 *will almost completely destroy the bactericidal power of human leukocytes, while, at the same time, it has practically no inhibiting action on the growth of staphylococci.*" This observation is based upon an experiment, adequately controlled, in which leukocytes, serum, staphylococci and carbolic acid are incubated together for a period of twenty-four hours.

The second inquiry was to discover whether momentary contact of leukocytes with antiseptics had any effect on inhibiting the bactericidal power of the former. In this experiment the leukocytes were exposed for a moment to the action of the antiseptic, which was then quickly washed away by serum. The result appears on p. 179.

The table shows that the leukocyte is extraordinarily susceptible to even the momentary action of an antiseptic.

Antiseptic used.	No. of colonies developing.
Control tube, no leukocytes or antiseptic	Innumerable (over 200)
Control tube, leukocytes, no antiseptic	One.
Experimental tubes, leukocytes plus :—	
Iodine 1 in 100 . . .	Innumerable.
Carbolic acid 1 in 20 . .	,,
Picric acid 1 in 200 . .	,,
Mercuric chloride 1 in 1,000.	,,
Eusol	,,
Alcohol	,,
Ether	,,
Chloroform . . .	,,
Flavine 1 in 1,000 . .	,, (not so many)

Referring to an experiment to show the growth of staphylococci when mixed with defibrinated blood and carbolic acid in different dilutions, Fleming says :—" It will be seen that in the control cell (without antiseptic) out of fifty-six cocci implanted, only one colony has developed with concentrations of carbolic acid from 1 in 20,000 to 1 in 25,000; the results were not materially different from the control. This range of dilution, where the antiseptic solution has no effect either on the bacteria or on the anti-bacterial power of the blood, might be called the ' Indifferent Zone.' In the cell containing a concentration of the antiseptic of 1 in 1,280, there is a great increase in the number of the colonies, and in the next cell, which contains 1 in 640 carbolic acid, it will be seen that every staphylococcus implanted has grown out. Here, then, we have an ' Anti-bactericidal Zone ' where the antiseptic, far from having any inhibiting action on the bacteria, increases the growth, owing to its interfering with or completely destroying the bactericidal power of the blood. Finally, in the cell containing 1 in 320 carbolic acid, no

colonies develop, and here we may assume that, although the anti-bacterial power of the blood is destroyed, this concentration of antiseptic is sufficient to inhibit completely the growth of the bacteria. This might be called the 'Antiseptic Zone.'"

I have quoted the foregoing experiments with carbolic acid in some detail as an illustration of the methods used, and also because of their fundamental importance. Similar experiments were carried out with other antiseptics whose anti-bactericidal power varied, but in nearly all there is considerable antagonism to the leukocyte. For example, I quote again from Fleming's paper his remarks on eusol, as it is a substance which is often advocated by obstetricians in the treatment of septicæmia. Fleming says: "This (eusol) is an antiseptic which has been recommended for intravenous injection in cases of septicæmia [quotes Lorrain Smith, Drennan, Rettie and Campbell] (3). It will be seen from the table (not reproduced) that *equal parts of this antiseptic and blood furnish a good culture medium for staphylococci*, and that practically all the staphylococci introduced grow out in this mixture. In view of this result, which has been confirmed by many experiments, it seems hardly possible that anything but harm could result from large injections of eusol into the blood stream. The amount recommended for injection was 150 to 200 c.c., which when diluted with the total volume of blood, say 5,000 c.c., would make the concentration such that it would fall into the 'Indifferent Zone,' in which no effect would be produced either on the cocci or the blood cells."

The case of flavine was found to be rather different, as no anti-bactericidal zone could be demonstrated by this technique. But Fleming (4) showed that when flavine was allowed to remain in contact with leukocytes for five hours the phagocytic power of these was seriously interfered with by a concentration of 1 in 500,000. Flavine might possibly be regarded as a suitable antiseptic for injection in cases of septicæmia, but again, Fleming shows by a further experi-

ment that the slight and early inhibitory power on the growth of cocci in the blood disappears about three minutes after its injection because the fixed tissue cells only, and not the serum, possess an affinity for the compound, as shown by tissue staining.

These experiments make it abundantly clear that antiseptics injected into the blood stream can have no beneficial effect whatever on the condition of septicæmia. The argument may be carried a stage further from the blood stream to the uterine cavity. Here again I touch on a popular line of treatment of the infected uterus, namely, the irrigation or cauterisation thereof by strong antiseptic solutions. But the chief action of the antiseptic is to paralyse the leukocyte, and only after that, and even then only if in dangerous strength, will it kill the organisms. Moreover, antiseptics can penetrate but a very thin layer of tissue, fortunately, so that only microbes lying loose in the cavity of the uterus can be reached, while the combination of many antiseptics with albuminous fluids either precipitates them from solution or, in some other way, renders them useless as bactericidal agents.

In no disease more than septicæmia is it important to beware of a judgment based on the results of treatment of a few cases. Puerperal fever, even of a severe degree, is liable to sudden spontaneous improvement in spite of any treatment, and this change is often noticed as soon as proper nursing care is established, which usually coincides with the commencement of some special mode of "scientific treatment."

From time to time cases of apparent severity are published treated successfully by the intravenous injection of an antiseptic, such as eusol or mercurosol, but after the success of the initial cases there is a failure of sustained clinical evidence to support further trial.

I do not maintain that no antiseptic will succeed in the treatment of septicæmia, but rather that none will succeed

which cannot be shown to render the patient's blood definitely and strongly bactericidal to hæmolytic streptococci. It is doubtful whether any drug known at present can be said to fulfil this ideal. The salvarsan and neo-salvarsan group approach it more closely than any other. They appear to act more or less directly upon hæmolytic streptococci both *in vitro* and *in vivo* (Colebrook and Todd).[1] Other streptococci are not affected by them. Leukocytes seem to have less affinity for them than is the case with most of the other antiseptics.

Allison (5) has reported that in a series of septicæmic rabbits experimentally infected by him with streptococci, seventeen of the twenty-five treated by arsenobenzol recovered, as compared with eight out of twenty-one control animals. While it does not appear likely that the bactericidal enrichment of a patient's blood obtained by this means will be sufficiently great to save the most heavily infected cases, there is ground for hoping that these drugs might turn the scale in the less severe ones, especially if combined with immuno-transfusion.

Pending further research a dose of 0·6 grm. novarsenobillon is recommended. Miller and Chalfont (6) report a series of eleven cases treated by arseno-benzol. They selected cases having streptococci in the blood (not bacteriologically tested in their later patients) and gave 0·6 grm. of arseno-benzol, noting the leukocyte count before and after injection. If the leukocytes fell after the injection, but not the temperature, and the pulse, a second or third dose was given. A frequent result of the injection was an increase in the leukocytosis, and this was always associated with an improvement in the general condition. Sometimes the blood ceased to yield positive cultures after treatment by arseno-benzol. Of the eleven cases four, however, died, and this cannot be regarded as a very great improvement on existing methods of treatment.

[1] Unpublished researches.

Quinine

For many years quinine has been a favourable remedy for febrile conditions caused by infections apart from malarial fever. It has an action in reducing temperature, and by virtue of its antiseptic properties, has been credited with a direct bactericidal action on the circulating microbe, though it has a greater affinity for the leukocytes than microbes (Fleming). It is doubtful, however, as I have already pointed out, whether such action really exists, and it is probable that any good that follows its use is due to increased leukocytosis. Recently Luker (7) has made a fresh trial of quinine by an intensive method, combined with the use of anti-streptococcal serum. In the light of recent work, however, it will probably be shown that any improvement following Luker's method must be ascribed solely to the action of the quinine. He gives a few details of leukocytosis before and after quinine injection as follows :—

	Leukocytosis.	Polymorph.	Lymphocytes.
Before treatment . .	23,200	72·0%	16·0%
After treatment . .	10,880	72·5%	13·0%
One week later . .	9,200	66·0%	25·5%

This single case shows a fall in leukocytosis following quinine injection, which is in accordance with Cushny's statement that there is firstly a diminution in the number of white cells, followed later by an increase. But, as Colebrook and Storer point out, mere leukocytosis or movement of the number of white cells is no real guide to the resistance of the patient. It is necessary to know not only their numbers, but their efficiency or "killing power." In severe cases of septicæmia there may be a leukocytosis, but the individual cells are paralysed as phagocytes in the presence of bacteria, and, therefore, are a useless defence for the patient.

Luker's technique is as follows :—

1.—Injections of anti-streptococcal serum :—

First day of disease . . .	30 c.c.
Second day of disease . . .	30 c.c.
Third day of disease . . .	20 c.c.

2.—Injections of quinine bi-hydrochloride, 5 gr. in 1 c.c. of sterile water, are made intramuscularly every day for six or ten days. The solution is massaged away from the site of injection. Later he gave three intravenous injections of 5 gr. of quinine bi-hydrochloride on alternate days.

Results.—Thirty-five cases of severe puerperal septicæmia were treated with two deaths (mortality 5·6%). During previous years the average mortality in the same ward had been 34·2%. There were no symptoms of cinchonism, and improvement began to show itself rapidly after injections had been begun.

The most striking result was the recovery of two cases of septicæmia complicated by panophthalmitis, a condition which is nearly always fatal. Before any final judgment can be expressed on Luker's method of injection of quinine, a more extended trial will be necessary, but the initial results are certainly promising.

Immunological Methods

Under this heading I include all those methods of treatment which aim at increasing the patient's natural powers of resistance. The usual immunological methods may be described under *active*, or vaccine therapy, and *passive*, or serums and blood transfusion.

Vaccines

Opinion has been sharply divided on the use of vaccines in puerperal or any other form of septicæmia, partly on theoretical grounds, partly because of the absence of recog-

nisable clinical improvement in the majority of cases treated. In 1923 Wright (8) stated certain " New Principles of Therapeutic Inoculation," in which the results of much research are laid down as another step forward in the science of immunology. While it is impossible, as well as inadvisable, to give an account of all the experimental work in a volume of this kind, the conclusions as affecting septicæmia may be summed up that " in all immunisation quantitive considerations dominate the situation," or, in other words, the all-important point in immunological work is the dose used for the production of the immunising response. Further, " only a definite measure of additional anti-bacterial power is engendered, and that with it only such and such an additional number of microbes can be killed." In the light of these conclusions it appears, therefore, that it may not only be useless but dangerous to inoculate with a dose which has not been measured to the patient's capacity and requirements. The determination of the correct dose of vaccine is of far more value than knowing the species of the infecting microbe. For the treatment of any case of septicæmia it is, therefore, desirable to have exact information about the anti-bacterial power of the patient's blood, and her capacity for making an immunising response to vaccines; also, it is desirable to determine the nature and extent of the reaction to the inoculation already made. This requires a certain amount of elaborate laboratory technique close at hand, and a skilled pathologist versed in serological technique working in close co-operation with the clinician in charge of the case. If such conditions exist, treatment by vaccines or immuno-transfusion, as the case demands, is eminently desirable. But it is only in exceptional circumstances that these ideal conditions will be found, and if, therefore, treatment has to be undertaken without hæmatological control by the pathologist, then it is wise to regard a case of puerperal septicæmia as so heavily toxic as to be unsuitable for vaccine therapy, and only to be treated by the transfusion of blood from an inoculated donor.

Sera

There is no more widely practised mode of treatment of puerperal fever than by sera. Various forms are used, such as normal horse serum, anti-streptococcal, anti-diphtheritic and normal human sera. Not only has the variety been numerous, but perhaps even more varied has been the dose, time and repetition of administration. It is not uncommon to find one woman having a dose of 10 c.c. which is not repeated, while another will have 100 c.c. per day repeated for so long as there are available areas left for its injection. Everybody who has used sera has given his opinion thereon, varying from the man who pins all his hopes to sera to the exclusion of other methods, to the man who, having used them for years, finally gives them up as worthless.

On a matter of this kind where clinical conditions differ to such an extent, and where observers are so often ill-qualified for arriving at judicial opinions on the value and results of a method of treatment, and where, finally, the serum method may be combined with many others, it is impossible to form a clinical opinion of any value. One of the essentials of scientific experiment, namely, constancy of conditions, does not exist in this inquiry, and, therefore, no deductions of scientific value can be deduced from the observations. It is permissible, however, for a clinician to assume a sceptical attitude on the value of any line of treatment about which there are marked variations of opinion, or at least, to lay the onus of proof on those who claim that serum therapy can produce results. At nothing else so much as serum therapy may the laboratory-confined pathologist be allowed his jeer, at the expense of the clinician. We need exact evidence, and this can only be furnished by the serologist. If by experiment he can tell us that there is unmistakable increase in the killing power of the patient's blood after exposure to the therapeutic sera either *in vivo* or *in vitro*, then there will be a case for the use of sera, but if no evidence of increased

killing power can be discovered when the sera are used for experiment in the ordinary therapeutic concentrations, then the clinical use of sera for streptococcal infections should be entirely discontinued.

Some work on these lines is now being undertaken by Dr. Todd in the Pathological Institute at St. Mary's Hospital to clear up this matter, but I understand that the preliminary examination fails to show that sera possess any immunising power ; indeed, some of the sera obtained on the market have already been shown to possess a *de-immunising* power, *i.e.*, after mixing with blood in various dilutions the blood exerts *less* killing power on organisms added to it.

Blood Transfusion (Immuno-Transfusion)

It seems reasonable on elementary grounds to expect that the injection of healthy blood into a patient having blood of exhausted resistance would impart to the latter an increased capacity for fighting infection. Moreover, it would seem, *a fortiori*, that if the resistance of the donor's blood could be exalted before injection by active measures the effect on the patient would be still more marked. Since the war Colebrook, Storer, and other workers of Sir Almroth Wright's laboratory (9) have applied this method to a large number of cases of septicæmia. In judging their results Colebrook and Storer point out that it is as impossible to apply the statistical method here as in most other observations, owing to the varying conditions of each case and the comparatively small numbers on which to base statistical evidence. They judge their results by a striking clinical response of a patient in a desperate condition, or by a consequential change in the immunological condition of the blood following blood transfusion, and, best of all, by a combined clinical and immunological improvement.

They report a few striking cases of cure of desperate, almost moribund patients, but at the same time confess that

other patients have for unknown reasons refused to respond. This experience is in accordance with my own. For example, a woman at Queen Charlotte's Hospital with a streptococcal blood infection following placenta prævia developed temperatures of 105·6° on two evenings and 108° on one occasion, with a pulse of 154. There were three rigors, and the patient's general condition appeared to be hopeless. Anti-streptococcal serum and other treatment had been ineffectual, so she was given a transfusion of citrated blood to which 25 million dead streptococci per cubic centimetre had been added. The temperature fell to normal forty-eight hours after the injection and did not rise again. As I have stated before in this chapter, great caution must be exercised in attributing improvement to the treatment adopted, but here I observed the most dramatic change follow immediately after transfusion, and it was irresistible to conclude that the result was directly consequent upon the treatment. Unfortunately the blood was not examined immunologically before and after the injection was made.

The aim of immuno-transfusion is to inject a blood which contains a bactericidal plasma and leukocytes, for both these elements play a *rôle* in defence. It is important to know which patient is suitable for transfusion. Theoretically, if the blood still possesses the power of response to an infection by the production of anti-bacterial substances the logical treatment is by a vaccine, but if, as is so often in clinically severe septicæmia, the leukocytes are paralysed even though they may be increased in numbers, the use of vaccines can do nothing but harm, and the correct line in the present state of our knowledge is the injection of a highly active whole blood. The choice of a donor is a matter of obvious importance. Preferably he should be of the same blood group, but in default of this, a universal donor may be employed. The compatibility is readily tested on the spot by mixing a drop of the donor's blood with a drop of the patient's serum on a glass slide. Incompatibility is noted in a minute by

the agglutination of red corpuscles to form small masses visible to the naked eye. (In default of a specimen of the patient's serum where time is of great importance, as in hæmorrhage, the writer has placed a drop of blood from both donor and patient on the window-pane and noted the occurrence or absence of agglutination.) The immunisation of the donor's blood is accomplished by giving him an injection of 1,000 million staphylococci subcutaneously. Four hours after the injection his blood has gained an exalted bactericidal power, and he is ready for bleeding. As the aim is to obtain a large amount of the " non-specific " antibodies, the use of staphylococci is permissible and convenient whatever may be the infecting agent of the patient. The increased hæmo-bactericidal power of the donor's blood is lost after about forty-eight hours.

Colebrook has shown that it is better to defibrinate the blood than citrate it at the time of bleeding, as the addition of citrate or any other chemical agent for the prevention of clotting materially impairs the power of producing antibodies. Defibrination is easily carried out, and defibrinated blood is easier to manipulate afterwards in making the transfusion ; moreover, there is no danger of injecting a blood of which the fibrin ferment is active. For a description of the details of technique the reader is referred to Colebrook and Storer's original paper.

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PART II. GYNÆCOLOGY

CHAPTER IX

THE GENERAL PROGRESS OF GYNÆCOLOGY

In common with other branches of medicine and surgery, that which deals with diseases of women has made real progress during the last ten years. Pathology, diagnosis and treatment have all shared in the advances of knowledge, with the result that gynæcology rests upon a surer scientific foundation than it has ever done before. Much laboratory work has been done in the domain of histopathology, notably that dealing with ovarian tumours. The means of accurate diagnosis have been considerably extended by the introduction of new methods, best exemplified by the technique of inflation of the Fallopian tubes for the detection of obstructions, and thus the causes of sterility.

It is true that the limit in diagnostic methods by unaided clinical examination of the patients has been reached, and that all further advances in accurate diagnosis must arrive by the help of the ancillary methods of the laboratory and X-ray room. There is, perhaps, a danger that the younger clinicians, fascinated by the apparent exactitude and ingenuity of these ancillary methods, are relying too much thereon, and failing to cultivate the invaluable *tactus eruditus*, for it is upon this, and this alone, that true clinical experience can be obtained and sound judgment formed. In this respect gynæcology shares the dangers of all branches of clinical medicine, and it is really questionable how far a sound judgment can be made by reliance upon mechanical methods of

diagnosis alone. There is no doubt whatever as to the value of these methods, but their very attraction makes their innovation into clinical methods more insidious. Any loss of clinical skill by disuse must considerably impair the efficiency of the practitioner, however much he may be guided by the pathologist, the radiographer and other diagnostic assistants.

However well versed in all the newest pathological discoveries and diagnostic investigations, there is no doubt that there can be no man more valuable to the patient than the one who has a ripe clinical experience. Only time can test the value of new methods, and it remains for the clinician to pronounce the final verdict, selecting the very small element of the new which is good and durable, while rejecting the mass of what is fallacious and valueless. I do not wish to give the impression that new methods in diagnosis and treatment are of little value ; it is obvious that they can only be appraised by the fullest investigation, but it is well to offer a word of warning against the acceptance of new methods simply because they are new, and sometimes because they are elaborate. It is obvious that new knowledge can be obtained only by unfettered research, and all means of investigation are desirable and necessary for this end, but it must also be borne in mind that clinical work is unable to use investigatory methods as a routine, partly because they are only fitted for investigation, and partly because they prove, in the light of further knowledge, to be unreliable.

In the domain of treatment there have been great strides chiefly in the direction of the use of radium and X-rays, which will be considered in detail in subsequent chapters. Operative technique has advanced comparatively little, and chiefly in detail ; the major procedures of the surgery of the pelvis have become standardised and accepted, and most of the innovations of surgery have taken the form of comparatively minor modifications of technique. From time to time new operations have been described, but on the whole they do not greatly improve, if at all, the standard methods. It

will be well to describe in some detail the results of operations with certain points in their technique, which have been published recently.

Prolapse. –The radical cure of prolapse of the uterus and vagina after years of discussion has at last been standardised by Fothergill of Manchester (1). It is probable that no further improvements will be made on his method and technique, as the results of his operation are as good as can be expected of any operative cure, and the method has the great advantage of simplicity. For years the contention has been the question of correction of the accompanying retroversion of the uterus, for, as everybody realises, an operation for prolapse which leaves the uterus retroverted is only half done and very likely to be followed by recurrence, *i.e.*, a utero-vaginal prolapse in place of the ordinary vagino-uterine prolapse for which the operation was originally undertaken. The appreciation of the importance of retroversion in prolapse led operators to combine an abdominal suspension or fixation operation with the perinæorrhaphy. This was a long and cumbersome procedure requiring a change of position during operation and two sets of instruments and towels. The risk was immediately increased once the abdomen was opened, and the convalescence was longer. The performance of an abdominal fixation alone for prolapse, *i.e.*, without repair of the perinæum at the same time is, of course, an indefensible procedure, but from time to time we meet some wretched patient who has suffered this form of maltreatment and is seven times worse than before the operation.

The elimination of the abdominal operation for severe prolapse is a great advantage, and Fothergill has shown that the worst case can be effectually cured by the vaginal operation alone. This view is shared by all who have followed his technique. Fothergill (2) gives the end results of 156 operations done between 1914 and 1916. These patients were traced, and as far as possible examined. One hundred and fifty women stated without qualification

that they were cured, while six did not, but of these six two were found on examination to be free from anatomical prolapse. This yields a result of $97\frac{1}{3}\%$ free from recurrence of prolapse after five or more years. In most of these operations (124) the combined procedure of anterior colporrhaphy with amputation of the cervix was done, but the

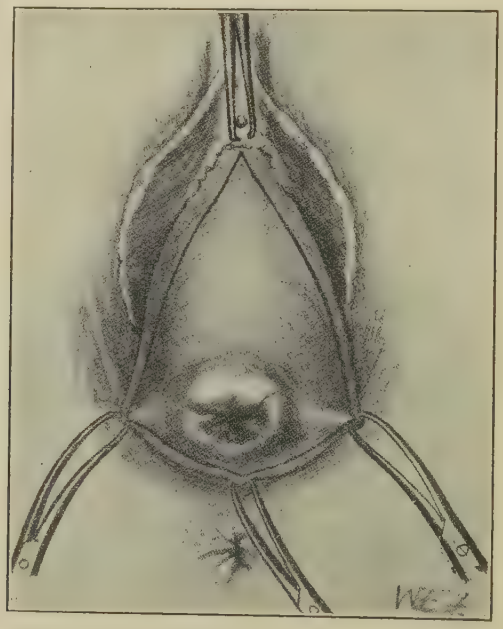

Fig. 12.

most interesting point of Fothergill's series was that thirty-two cases were those of utero-vaginal prolapse, *i.e.*, inversion of the vaginal wall from above with a descending uterus and elongation of the cervix without any perineal lesion, most of them having occurred in nulliparous women. This is a notoriously difficult form of prolapse to cure, and is usually dealt with by the abdominal method.

Though Fothergill published his technique as long ago as

1913, yet I feel that some account of the operation should be included here as it has done so much to improve the treatment of prolapse. The accompanying diagrams will make clear the steps of the operation.

"Fig. 12 illustrates a modification of ordinary anterior colporrhaphy which is useful in cases of true prolapse when the uterus is not elongated and when the cervix is healthy

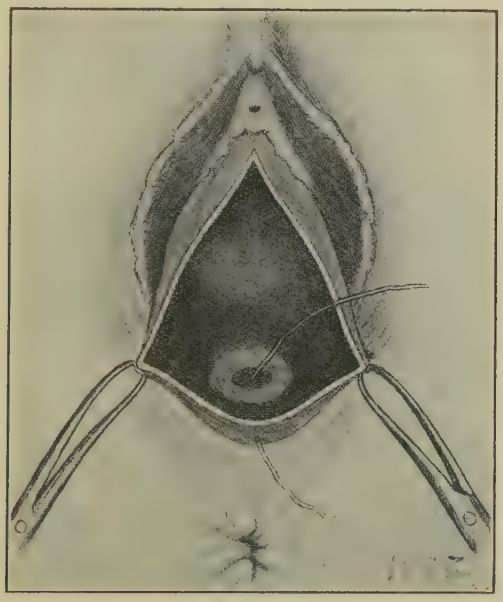

Fig. 13.

and not hypertrophied. The dotted line shows the usual incision. The plain line shows the incision extended upwards and backwards on both sides of the cervix so that the wound becomes a triangle with its apex at the urethral orifice and its broad base crossing the vaginal roof just in front of the cervix. The closure of this wound from side to side brings together in the middle line in front of the cervix the tissues which formerly lay at its sides. The cervix is thus pushed

upwards and backwards towards the hollow of the sacrum. The body of the uterus at the same time passes forwards into a position of anteversion and is kept there by intra-abdominal pressure. The recurrence of prolapse is thus effectually prevented. The operation is completed by a moderate repair of the perinæum done so as to restore the natural size, slope and curve of the vagina.

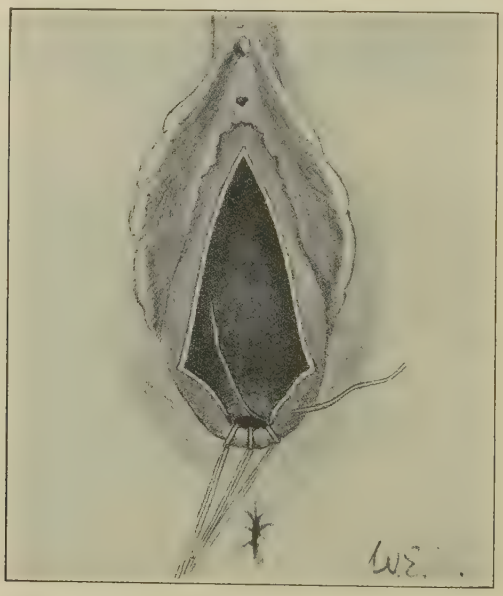

Fig. 14.

"Figs. 13 to 16 illustrate the combination of anterior colporrhaphy with amputation of the cervix as a single operation. This device is useful in cases of true prolapse whenever the uterus is more than 3 in. long, and whenever the cervix is unhealthy and lacerated. It is also used in cases of elongation of the cervix with inversion of the vagina from above downwards. In short, whenever it is necessary to amputate the cervix when operating on any variety of genital prolapse,

it is best to remove the cervix together with part of the anterior vaginal wall. The ordinary method of amputation of the cervix is a bad preliminary to an anterior colporrhaphy ; and when these two operations have been done *seriatim* the uterus is left in a position of retroversion, with the cervix looking downwards and forwards and much too near the vaginal orifice.

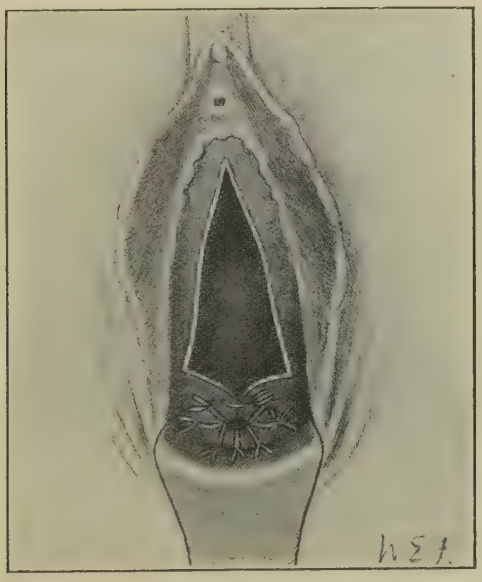

Fig. 15.

" It is therefore better to combine the two operations in one after a preliminary dilatation of the cervix and curetting. The incision for this purpose is shown in Fig. 13. When the vaginal wall, enclosed by the incision, has been separated from the bladder and the paravaginal and parametric tissue the cervix is clipped round and round as far as may be necessary. It is then cut straight across so as to leave the uterus not more than 3 in. long. The amputated portion

of the cervix comes away in one piece together with the flap of vaginal wall. Fig. 14 shows the appearance of the wound.

"Figs. 15 and 16 show the way in which it is closed. Catgut is the only suture material, as after this operation it is impossible to get access to the parts for the removal of stitches.

"When the stump of the cervix has been covered in the

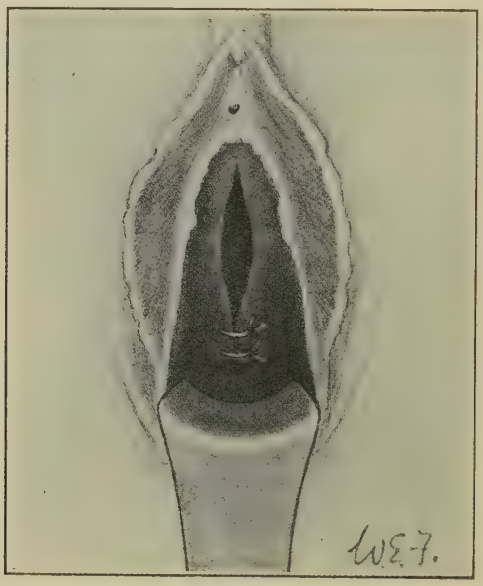

Fig. 16.

sides of the wound begin to approach one another in front of it. The cervix then recedes towards the hollow of the sacrum, and the remaining stitches must be tied with the fingers within the vagina. For if enough vaginal wall has been removed the sides of the wound will not come together unless the uterus is well within the pelvis. At the end of the operation the stump of the cervix is far back, high up, and out of sight; the uterus is in anteversion. The perinæum

should be repaired so as to restore the original condition without unduly narrowing the vagina " (3).

On the whole the tendency in operative procedure has been in the direction of conservatism of the pelvic structures in an attempt to preserve the function of child-bearing and to maintain normal menstrual life without the premature development of the symptoms of the menopause. Examples of this movement are in the surgery of fibroids, the ovary and Fallopian tube.

Myomectomy.—The clinical indications and results of this operation have been recently studied and published by Giles (4) and by Bonney (5). According to Giles the chief indication for myomectomy as opposed to hysterectomy is that the patient is of child-bearing age. It is obvious, however, that this qualification must be limited. A married woman of below forty who has hitherto failed to conceive is eminently suitable for myomectomy, while a single woman of thirty-five is perhaps a less suitable subject, as her expectation of children can only follow on the contingency of marriage, which must first be accomplished. On the other hand, a single woman contemplating marriage may be particularly desirous of retaining the uterus if at all possible. The problem, however, scarcely arises in a married woman of say, thirty-five, who has had several children. Here the desire to be rid of the fibroids and any possibility of their recurrence will far outweigh any desire, which is most unlikely to exist, of having still more children. It is, therefore, necessary to take into consideration many attendant circumstances in addition to the age of the patient, and every one must be considered on her merits.

Occasionally there may be a sentimental regard for the possession of the uterus which will strongly influence a woman in her choice of operation. Giles mentions the danger of mental unstability which may follow hysterectomy, chiefly in nulliparous or unmarried women, if the uterus is removed against the strong desire to retain it. Where this desire is

obvious and emphatic every possible effort should be made to perform myomectomy in view of the mental depression which is sure to follow.

The number, position and condition of the tumours are also points to be taken into consideration. Generally speaking, the solitary subperitoneal or interstitial tumour is the ideal condition for myomectomy, but almost any number can be dealt with if necessary. Some forms of degenerated fibroids can also be enucleated, including "red fibroids," but those which are infected or which have large nævoid sinuses are better treated by hysterectomy on account of infection or hæmorrhage.

Cervical fibroids are less amenable to enucleation owing to the elongated cervical canal accompanying them, but small ones may be shelled out. The association of pregnancy, far from being a bar to the operation, may be an indication if the tumour threatens obstruction, causes pain, or is so large as to embarrass by its size. A single subperitoneal fibroid may be removed without any disturbance of pregnancy in the majority of cases, and even an interstitial tumour only slightly increases the risk of abortion. In one case the writer incised the uterine wall until the amniotic membrane was reached, but the pregnancy of four months proceeded undisturbed. It is impossible, however, in pregnancy to remove a number of tumours owing to hæmorrhage and the risk of abortion. In practice the latter is never required. The operation is only undertaken in pregnancy to relieve the pressure caused by a single tumour or a certain source of obstruction in labour.

Considered from the point of view of symptoms: pain, sterility, or pressure on the bladder, rather than menorrhagia are the indications, though a moderate degree of menorrhagia can be properly treated by myomectomy. Very great menorrhagia may mean a fibroid polypus which is better treated by vaginal hysterotomy. But sometimes it is due to the occurrence of intra-uterine mucous polypi or hyper-

plasia of the endometrium which can easily be removed at the time of doing myomectomy by curettage. The contra-indications of myomectomy are chiefly the age of the patient and the complexity of the tumours. After the age of child-bearing, *i.e.*, about forty-three, there is little or no advantage in saving the uterus, and in the great majority hysterectomy is the proper operation. An exception can be made where there is a single stalked sub-peritoneal fibroid which is quickly removed by snipping through the pedicle. So simple a myomectomy is quicker than hysterectomy and involves less risk. If the uterus is deformed by an innumerable number of tumours the attempt at myomectomy is a hopeless procedure. As fast as they are shelled out fresh ones are found buried in the uterine wall, and the organ is left in a scarred and deformed condition, which is unlikely to be capable of conception, though the use of Bonney's clamp (see Appendix) renders it technically possible to remove an indefinite number of fibroids. Justification of this operation as opposed to hysterectomy rests upon the subsequent possibility of pregnancy, and a very small risk of further development of fibroids with another operation necessary for their removal.

Giles gives his experience of the possibility of pregnancy after the operation as follows :—

Of fifty patients under forty-five who had chances of conceiving after the operation, fourteen became pregnant, or 28%. Considering the tendency of patients with fibroids to sterility, this is a notably high figure. Indeed, it is permissible to go farther and say that in some young women with a large solitary fibroid, who complain of sterility, myomectomy is the proper treatment for the latter condition apart from any other symptoms the tumour may be causing. The writer has been surprised to find how soon conception may follow such a myomectomy in a previously sterile woman.

In cases of repeated abortion there may be a similar happy result in the prevention of any further abortion after the fibroid is removed.

The examination of the after-histories of his patients leads Giles to state that the risk of recurrence of fibroids is 10%, though in some of these the fibroid was entirely unimportant, causing no symptoms. Menorrhagia is maintained or recurs in Giles's series at the rate of 20%. This is more important than the rate of recurrence of the fibroids, because some of these are unimportant, while menorrhagia may be an insistent and distressing symptom. The persistence of menorrhagia is due to the hyperplastic or polypoid endometrium or a small stalked fibroid in the uterine cavity. So frequently is one or other of these conditions found when menorrhagia is a symptom that the operation should include the deliberate opening and curetting of the uterine cavity, great care being taken to prevent contamination of the peritoneal cavity by the fragments of endometrium (see Chapter XI.). If the uterine cavity has been cleared of all hyperplastic endometrium or fibroid polypi the chance of persistent or recurrent menorrhagia is extremely small. The uterine muscle being healthy and capable of involuting after myomectomy, there will be no further tendency for overgrowth of the endometrium.

The risk of subsequent operation for fresh fibroids or menorrhagia is 3% in Giles's series. This is a low figure and is striking evidence of the curative value of the operation. The immediate risk of myomectomy scarcely differs from that of hysterectomy. For example, Giles quotes hysterectomy, 0·97%; myomectomy, 0·93%.

The Ovary.—Conservative work on the ovary has long been practised in view of the well-known importance of the ovarian hormones. It is, indeed, rarely necessary in a young woman to remove both ovaries entirely, though occasionally advanced suppurative inflammation may render this inevitable. In order to avoid the unpleasant symptoms of the artificial menopause in a young woman following ablation of both ovaries, attempts have been made during the last ten years to graft small fragments of healthy ovarian tissue taken

from the excised mass in the abdominal wall, either in the extra-peritoneal fat or rectus muscle. Tuffier (6), a pioneer in the operation of ovarian grafting, has recently given an account of his results over a period of fourteen years' work. He describes the experience of 230 operations. The aims of ovarian grafting are firstly to conserve the function of menstruation after total removal of the ovaries and thus to obviate the surgical menopause, and secondly, to render the menopause, when it does arrive, as natural as possible, and thus mitigate the severity of the symptoms which so often follow total surgical removal. In Tuffier's hands the homoplastic graft, *i.e.*, the transplantation of the ovary or portions thereof, from one woman to another is never successful. This observation is based upon an experience of twenty cases. The autoplastic grafts were made in 203 cases, chiefly into the sub-peritoneal fat and subcutaneous cellular tissue, though the actual site of the graft appears to have little influence on subsequent function. The most important consideration appears to be the age of the patient. In only one case after forty years of age was menstruation maintained, while a girl of eighteen at the time of the operation has continued to menstruate for twelve years. After convalescence the graft does not betray its presence for about five months, when, if it is successful, it causes a little local swelling and discomfort just before the menstrual flow is established. The reason for the latent period between the operation and the re-establishment of menstruation is temporary avascularity of the graft. As soon as vascular connection has been accomplished the hormonic secretion can be absorbed. Should menstruation follow the operation immediately without any interruption, the strong probability is that a small fragment of ovarian tissue has escaped the attempt at complete ablation and remains, *in situ*, in the pelvis.

It is interesting to note that menopausal symptoms supervene during the latent period, but disappear at once if menstruation appears, and further, that if the

graft is removed for any reason menstruation ceases at once.

Menstruation is seldom of normal regularity after ovarian grafting either in time or amount, but rarely causes trouble except occasional menorrhagia.

Of seventy-three cases fifty-six (77%) menstruated with varying regularity from four months to twelve years after the operation. The duration of menstruation is as follows in Tuffier's series :—

Fourteen cases for six months.
Thirteen cases up to one year.
Eighteen cases from one to two years.
Four cases from two to three years.
One case for three years.
One case for twelve years.

It is thus obvious that ovarian grafts can gain vascular attachment and function as an endocrine gland, but the length of their life is disappointing. While it may be of some slight advantage to maintain menstruation and stave off the menopause for a few months or even years, Tuffier claims that the real advantage lies in the milder character of the menopause when it finally arrives compared with the severe symptoms that follow the abrupt removal of the ovaries in young women.

Objections to ovarian grafting are few in number. There is no mortality of the operation which can be directly traced to the procedure of grafting. Rarely a cystic growth may develop in the graft, as described by Lack (7), but this writer states that he could find mention of only three other cases recorded, and no case of malignant growth.

A further matter relevant to the question of ovarian conservation is the treatment of the ovaries at the time of performance of hysterectomy for fibroids. Some operators always conserve the healthy ovary, while others make a routine practice of removing the ovaries with the uterus on

the ground that they cannot continue any reproductive functions, but are liable to morbid changes which are commonly seen with uterine fibroids and are therefore a menace to future health. Moreover, it is held that in women over forty ovarian atrophy after hysterectomy will rapidly occur and the surgical menopause is quickly passed when the uterus is removed with the ovaries. Our knowledge of the important endocrine function of the ovary inclines the writer to feel strongly that in young women (*i.e.*, under forty) with healthy ovaries, showing no undue hyperplasia or cystic change, these organs should be conserved, but if the patient is over forty, and especially if the ovaries are enlarged and cystic they should be removed with the uterus if hysterectomy is being undertaken for fibroids. The problem has been considered by Maxwell (8) by a study of the menopausal symptoms of 500 women who had been subjected to hysterectomy. The first conclusion is that the frequency of vaso-motor symptoms is about twice as great where the ovaries have been removed as when they have been retained. But even when conserved the ovaries are very liable to undergo atrophy as early as the first year after operation, as judged by the onset of delayed menopausal symptoms shown by the following table :—

Onset of Delayed Menopausal Symptoms with Conserved Ovaries

	No. of cases.	Per cent.
Six months . .	14	56
One year . .	5	20
Two years . .	2	8
Three years . .	3	12
Five years . .	1	4

Thus, more than half the cases suffered from vaso-motor symptoms so soon as six months after the operation, even when the ovaries were left *in situ*. The duration of the

surgical and natural menopause is about the same; that is, between two and three years, but the severity of the symptoms appear to depend chiefly on the temperamental constitution of the patient, though severe symptoms are more than twice as frequent if the ovaries have been removed. The age of the patient at the time of the operation is an important point for consideration, for during the earlier years, *i.e.*, below thirty-six, the ovaries appear to be far more virile and capable of preventing the menopause. A further important factor is the presence of anæmia. If the anæmia, so often seen before hysterectomy is performed for fibroids, is marked, vaso-motor symptoms are likely to be much more frequent than when a patient is in good condition.

Lastly, Maxwell observed, as we should expect, that if the ovaries are in good normal condition when the operation is done their function will be much more durable than if they are found to be sclerotic or cystic.

It is therefore necessary to recognise that the ovaries and uterus form a system which by their interaction, possibly with the assistance of the other ductless glands, are able during their functional life to maintain the woman free from menopausal symptoms, but that when this balance is upset, especially by removal of the ovaries, but also of the uterus, symptoms of the menopause will sooner or later develop. On clinical grounds it seems that the ovary is directly responsible for this maintenance, for ablation of both ovaries at once will precipitate the menopause, but if the uterus alone is removed the ovaries appear to be deprived of some stimulus which maintains their virility. In sharp contra-distinction to the ovaries the uterine factor appears to vary in different women, for simple removal of the uterus, leaving healthy ovaries intact in a young woman, in many cases is not followed by menopausal symptoms for many years.

It seems therefore certain that healthy ovaries should always be conserved when doing hysterectomy in a woman below forty, partly because they are able by themselves in a

number of patients to maintain the metabolic state unchanged and partly because if vaso-motor and other symptoms do supervene their incidence is easier for the patient than after oöphorectomy, as the gradual failure of their secretion allows a " smoother metabolic adjustment."

Where the ovary is not entirely diseased, as in certain cystic conditions, causing ovarian pain, much may be done to conserve sufficient ovarian tissue by enucleation of small cysts, or a wedge-shaped resection of the cyst-bearing portion of the ovary. If small lateral portions are left attached to the hilus and sutured by mattress stitches, a small but invaluable piece of ovarian tissue is preserved.

Attention has also been devoted to the ovarian veins by some writers, chiefly American. Emge (9) describes venous dilatation as a clinical entity, giving its symptomatology and treatment. Varicocele of the pampiniform plexus is a definite condition which can be observed at operation, but how far it exists without other conditions, such as prolapse of the ovaries or retroversion of the uterus, is an unsettled point. It is certain that women with much venous dilatation do suffer pelvic pain, chiefly felt on standing and before menstruation, but the clinical difficulty is to diagnose it before operation. Dilated veins, even in the standing position, can only form a soft swelling of comparatively small dimensions, easily mistaken for fæcal accumulation. If this is the only physical sign it can form a small justification for laparotomy, and most gynæcologists would operate with considerable reluctance and misgiving.

If, however, other physical signs exist, such as prolapsed and tender ovaries with retroversion, especially if associated with dyspareunia, then operation will probably be undertaken, but not primarily for varicocele, which can seldom be more than suspected. When operating, however, it is wise to bear in mind the possibility of the co-existence of varicocele and its potentiality, on analogy with the male condition, for causing pain. If the ovary, drained by greatly dilated

veins, is cystic it should be removed, provided the other is healthy, or, if much hypertrophied, a large cuneiform resection should be made to reduce its bulk and weight. At the same time the veins should be dissected out and partially removed, while the ovary should be suspended by a pleating stitch running through the ovarian ligament.

Retroversion.—On the matter of the importance of uterine retroversion as a cause of symptoms, and the necessity for operative treatment, there is still some difference of opinion. We have long passed the age when nearly every pelvic or other pain in the body was attributed to some degree of backward displacement, but there is still a tendency to incriminate the retroverted uterus, no matter whether there are any other physical signs or not, as a cause of obscure backache and pelvic pain. It is becoming generally accepted, however, that mere retroversion of an otherwise normal uterus is unlikely to be a cause of any symptoms whatever. In many women it is an accidental discovery during an examination for some other condition, while in others precisely the same symptoms attributed to retroversion can be found associated with an anteverted uterus. It is necessary, therefore, to realise that there must be something else other than simple retroversion. Thus, the uterus may be very tender, so that upward pressure for rectification cannot possibly be tolerated without an anæsthetic, it may be markedly enlarged or prolapsed, or the ovaries may be prolapsed and lying to one side or beneath it. In considering how far retroversion is a cause of symptoms, attention must be directed to the existence of these other signs and symptoms, especially dyspareunia. Operative replacement of a retroversion which exhibits other physical signs, and causes especially the symptom of dyspareunia, will be followed by complete cure in the great majority, but if undiscriminating operations are performed on uncomplicated cases of retroversion, many failures are bound to follow.

Many operations have been described to remedy backward

displacement, but in some there is too great a disturbance of normal anatomy to justify their adoption. The two most generally employed are the Gilliam method of intra-peritoneal shortening of the round ligaments and ventro-fixation of the uterus to the abdominal wall. The first of these is suitable for women below forty-five, and is usually a permanent rectification of the backward position. A disadvantage is that it is liable to be followed by some pain where the round ligaments are drawn through the rectus sheath. Another difficulty is that the round ligaments may be too attenuated to be of any sustentacular value. Ventro-fixation is more suitable for women past the child-bearing age, though it may be safely practised before this provided the sutures be placed low enough through the uterine body to allow of fundal expansion if pregnancy takes place. As a rule mere plication of the round ligaments is found to be insufficient, and to be followed by recurrence of the retroverted position because the distal extremity of the ligament is liable to be pulled backwards along the inguinal canal.

Carcinoma of the Cervix

The treatment of this condition by radical removal of the uterus and vagina was first initiated by Wertheim in 1906. He called it the " extended operation " for cancer of the cervix and distinguished his procedure from previous total hysterectomy :—

1. By insisting on the removal of the cervix in a cuff of the vagina by means of a special clamp applied to the vagina below the growth, whereby the danger of sepsis and carcinomatous contamination of the pelvic cavity was very greatly reduced.

2. By removal of the para-cervical cellulo-fatty tissue after separation of the ureters. This is perhaps the most characteristic step of Wertheim's method, for by separation of the ureters it is possible to act with much greater freedom in clearing away the cellular tissue at the base of the broad ligaments and along the lateral pelvic walls.

Later modifications of Wertheim's original operation are little more than variations in detail, but in one case is a distinct advance on the original method. We refer to the more extensive removal of the vagina. Many recurrences occur in the vault of the vagina, *i.e.*, in the scar, especially when an insufficient length of the vagina below the cervix has been removed. Experience shows that in those cases where the greater part of the vagina has been separated from above and removed, the chance of recurrence in the scar is very much reduced. The operation should really be termed utero-vaginectomy (or hystero-colpectomy) in order to emphasise the great importance of removing vagina, as well as uterus.

The actual steps of the operation are described in most text-books of gynæcology, but particularly clearly in Berkeley's and Bonney's "Gynæcological Surgery," 1920.

The possibility of the extended operation, or the *operability rate* vary in different surgeons' hands. Bonney (10) gives his rate as 63% of all cases of carcinoma of the cervix applying to the hospital for relief. This is a very high rate, higher than that of most gynæcologists, as he regards an operative attempt for so certainly fatal a disease as justified if there is the slightest possibility of successfully removing the growth. So high an operability rate naturally involves a high rate of primary mortality. The number of cases operated upon by any surgeon will, therefore, depend upon his view of a high operation risk, and how far much real benefit is conferred on the patient by a comparatively short freedom from recurrence which follows the long and debilitated convalescence after so severe an operation.

It must be entirely a matter of opinion. The writer's view is that the high mortality risk is worth taking, provided it is reasonably certain that the whole of the obvious growth can be removed. How far this can be accomplished can only be determined after opening the abdomen in cases which are doubtful by clinical examination. If careful palpation after

opening the abdomen reveals extensions which are impossible to remove completely, it is useless and wrong to subject the patient to a high risk of death for the sake of partial removal of a malignant growth. Involvement of the bladder, which can often only be proved by the attempt to dissect it off the cervix, should be a contra-indication to further procedure. Fixity to the pelvic wall and rectum, involvement of the ureters are similar bars to the operation.

The preliminary use of radium applied by needles and tube (see Chapter XIV) is of great value in rendering the growth more amenable to surgical removal. If the operation is carried out about a fortnight after the application of radium the immediate reaction produced by the radium will have settled down, and fibrosis, which commonly follows radium, rendering the operation so difficult, will not have had time to develop.

Mortality.—As already stated, the primary mortality of Wertheim's operation will largely depend upon how far advanced is the primary growth and its extensions, and the completeness of the operation. Many operators perform only an imperfect "Wertheim," and their mortality is consequently low. Others carry out a very radical operation with extensive removal of the vagina and glands, and, particularly if this is done for advanced cases, their mortality is of necessity higher. Individual skill, derived from oft-repeated practice, and, within limits, the speed of operation will also have a great effect on the mortality. A severe radical operation, occupying one and a half to two hours, will obviously exact a greater toll than the same operation done in forty-five minutes. After forty-five minutes every minute is of great importance. Other factors also to be considered very carefully are the general state of the patient, who is often in an exhausted condition, and the time and care expended in her preparation; the prevention of sepsis by careful local cleansing, not by caustic applications, but by drainage and douches, or scraping away fungating masses;

the prevention of unnecessary hæmorrhage at the time of the operation; and reasonable care in the after-treatment to combat shock.

Wertheim's original mortality rate was 25%, in his next series it had been reduced to 14%, while Berkeley, in 1909 (11), worked out the mortality in Great Britain as 18·1%. Bonney's latest figures (12) give a mortality of 16%, but it should be added that this comparatively high figure is the result of a very high operability rate. Bonney claims that in early picked cases the mortality is little more than that of ordinary hysterectomy. The writer's mortality in early and moderate cases is one death in forty operations (2·5%), but he is quite prepared to admit that this figure would rise very sharply if operation had been attempted on advanced growths.

There are so many factors which modify the risk of the operation, and so many ways of doing it which vary from little more than a pan-hysterectomy to a very radical utero-vaginectomy, that simple unqualified mortality figures are of little guide to gaining an idea of the risk for any one case. It should be remembered in discussing the subject with patients' relations that in early cases the complete operation can be done with little more than the risk of pan-hysterectomy, but in proportion to the sepsis and extent of the growth, the general anæmia and exhaustion, and the speed of the operation (often governed considerably by the place and conveniences of the operating theatre) the mortality risk will rise to the neighbourhood of 20%.

Results of the Operation.—The latest published results are those of Bonney (13). Of 192 operations performed five or more years ago he gives the following figures :—

Died of the operation	32	= 16% mortality.
Died of recurrent growth	70	
Died of other disease	5	
Lost sight of	7	
Well after five years	78	= 49% of cases who recovered from operation.

The incidence and effect of glandular metastasis is important. Carcinoma of the cervix differs from many other forms of carcinoma in its comparatively small tendency to involve the glands or give rise to distant metastases. Most observers agree that of all cases dying of cancer of the cervix, glandular metastasis is present in only about one-third.

Leitch found that in over 900 post-mortem examinations of women dying of cancer of the cervix unoperated upon, only 35% had metastases in the regional glands (quoted by Bonney). Glandular growths are chiefly found either in young patients or advanced growths, and when they occur they definitely influence prognosis for the worse, however completely the pelvic cellular tissue is removed. It is quite impossible to form any kind of clinical diagnosis of glandular involvement by mere inspection at operation, for small soft glands may contain a malignant nucleus, while large hard glands on the other hand may show nothing but inflammatory reaction.

The influence of glandular affection is shown as follows by Bonney's figures (microscopical diagnosis applied in all cases) :—

	Carcinomatous glands.	Non-carcinomatous glands.
Died of operation . . .	18	14
Died of recurrent growth . .	36	35
Died of other diseases . .	1	4
Lost sight of	3	3
Well after five years . .	20 = 33·3%	58 = 58%
Total . . .	78	114

The percentage of cases of five-year cure given in the above table is that of those who recovered from the operation, and shows very strikingly the malign influence of glandular

affection. Indeed, with metastatic glands a patient has only little more than half the chance of cure compared with a patient having the glands unaffected.

A comparison of the surgical results with those of irradiation by radium (see Chapter XIV) leaves no room for doubt that for operable cases surgical removal of the uterus is the only justifiable treatment. For inoperable cases it is certain that radium offers a considerable relief from pain and other symptoms, and it is very well worth using, but perhaps radium has its greatest sphere of practical usefulness in combination with surgery.

It is the practice of most gynæcologists now to apply radium according to the technique described in Chap. XIV (or some simple modification thereof) a short time before performing Wertheim's radical operation. The combination of the two methods appears to offer, in the present state of our knowledge, the best hope of permanent cure. An early case, especially if of the fungating variety, with no glandular involvement, treated by heavy exposure to radium and followed in a fortnight by the most radical operation, gives a chance of permanent freedom from cancer which has never hitherto been approached.

Curettage.—A more rational attitude towards the curette seems now to be manifest. The advocacy and use of the curette has passed through at least three phases during recent years, but now we hope that correct teaching and reading of long experience have lead to a certain amount of stability in our attitude towards this instrument. The extremes are illustrated by the promiscuous use of the instrument for almost every pelvic disorder which was practised some twenty years ago, and by the words of Emmett, who said :—

"As regards the instrument of Dr. Sims (the curette) I honestly believe that the ingenuity of man has never devised one capable of doing more injury" (14). This is the expression of an indignation perhaps justified by having seen the curette

used widely and unintelligently for almost every gynæcological symptom, but that it is literally an over-statement none of us would deny. However, it was perhaps necessary for teachers and writers to express in hyperbolic language their disagreement with a practice which, with the importance attributed to futile cervical operations, did much to bring gynæcology of thirty years ago into disrepute and even contempt. To those having an imperfect knowledge of pelvic pathology as we understand it to-day, and unversed in the technique of abdomino-pelvic surgery, it was a simple and comparatively harmless method of meeting gynæcological disorders, even if it did not actually treat them. We are not surprised therefore that the curette was used very widely and unscientifically in those earlier days.

The first great step towards rationalising the use of the curette came when it was realised that the radius of action of the curette did not, and could not, extend beyond the thickness of the endometrium, and that the cervical mucosa was not amenable to curettage, though it must be confessed that this latter elementary point has not yet permeated the whole profession.

It came slowly to be realised that the removal of the endometrium could have no influence on general pelvic pain, chiefly exemplified by premenstrual dysmenorrhœa, pain in the iliac fossæ, and backache, nor could it influence 99% of cases of leukorrhœa. The indications for its use were narrowed down to purely uterine conditions, *i.e.*, excessive uterine hæmorrhage, and particularly those irregular hæmorrhages following abortion and labour. The importance of the curette as a diagnostic instrument also began to be recognised. Even when limited to the treatment of uterine hæmorrhages of all sorts its application was still unscientific because the origin of most of these forms of hæmorrhages was attributed to a lesion or congestion of the endometrium, and the condition of the endometrium was then regarded not as the final expression of some deep-seated pathological change, but as

the initial cause, the *fons et origo* of the symptom of hæmorrhage. These were the days of elaboration of the pathology of so-called endometritis. " Scrapings " were assumed to be abnormal if menorrhagia was present, and some form of histopathology was invented to fall in with the clinical condition. Thus we had several varieties of endometritis, glandular, interstitial, atrophic, hyperplastic, and some others.

The next real advance was the work of Hitchman and Adler, who showed that the endometrium passes through a series of structural changes proper to each period of the month, before, during, and after menstruation. They showed that the elements of the endometrium may by their normal changes exhibit the features, *e.g.*, glandular hyperplasia, which had been previously described as endometritis, and that this condition might be found and diagnosed if it happened that the curettage was performed immediately prior to menstruation.

The findings of Hitchman and Adler have been to some extent criticised and modified by later workers, but the general facts remain, that the endometrium is not a resting tissue, but one which is undergoing cyclical changes throughout four weeks, and that any examination of uterine " scrapings " must have regard for the period in the cycle at which they were removed before a pathological condition can be attributed to them.

This work, therefore, was followed by a swing of the pendulum away from the position taken up anterior to it, of regarding nearly all " scrapings " as pathological, and as a sufficient cause for all forms of menorrhagia. If, therefore, the endometrium was usually normal, what was the use of removing it by the curette in the absence of certain possibilities of infection at abortion and labour ? The logical conclusion in the present state of our knowledge appears to be that the curette should only be used therapeutically to remove endometrium that is definitely abnormal, and that

abnormalities are only likely to occur after true intra-uterine infections accompanying abortion and labour, sometimes gonorrhœa alone, and a few cases of intra-uterine polypus or hyperplasia which is found with some cases of fibroids. Some writers, however, have gone farther than this, for example, Boree (15), who holds that the curette should be used for little else but diagnostic purposes, supporting his contention by referring to the frequent uselessness of the operation, and what he says are the " numerous disasters " which are liable to occur, particularly perforation of the uterus !

Now it is obvious that the operation will be useless if done for improper indications, but that true indications do exist is undeniable by everybody who will examine his clinical experience unprejudiced by exaggerated notions. Boree's views of the absence of infection of the endometrium, and, therefore, presumably of endometritis are based upon bacteriological examinations of the scrapings in which organisms were seldom found. For example, he quotes Curtis as stating that out of twenty-six nulliparæ curetted, with a history of infection, twenty-three uteri contained no organisms. Here is an example of unintelligent interpretation of pathological evidence in reading a clinical condition. The absence of organisms by cultural examination does not prove that they have not once existed in the uterus, leaving their trace by a chronic endometritis, nor that they were not there at the time of operation, as the cultural methods may not have been sufficient to reveal microbes in a dormant and possibly anærobic condition. It is as well, as Fothergill states (16), to bear in mind that the curette is of no value for : (1) Leukorrhœa, as the discharge always arises from the cervical mucosa which cannot be curetted, and only from the uterine body in very rare conditions. (2) Congestive dysmenorrhœa. (3) Dull aching in the sides—varicocele. (4) Menorrhagia, following an illness, such as influenza. (5) Menorrhagia following shock, such as a railway accident.

(6) One-child sterility, menorrhagia, or dysmenorrhœa in a patient who has a tubo-ovarian swelling.

There are also many other conditions treated by curettage for which it is quite useless, as, for example, young adult virgins with menorrhagia and no physical signs of pelvic disease.

It cannot be too forcibly emphasised that the curette is only of value when it can remove abnormal endometrium, of which the chief conditions are irregular bleeding following abortion or labour, and intra-uterine polypi usually found between forty and fifty years of age. Fothergill also recommends curettage as preliminary procedure in operation for prolapse. Here it is only an incident of a bigger operation, and even if necessary, it has not the same objection as when undertaken *ad hoc*. As a diagnostic instrument for the detection of malignant disease it is of the utmost value, and should be used in all cases of doubt when irregular bleeding occurs at or after the menopause. Even if the cause of discharge and bleeding is not carcinoma but "senile endometritis" the dilatation and exploration of the uterus for diagnostic purposes acts as excellent treatment by providing drainage.

"Functional Menorrhagia."—One of the most difficult types of case met with in gynæcological practice is that form of menorrhagia affecting young nulliparous women in whom no physical signs of pelvic disease can be found, and which defies all ordinary treatment. Menstruation lasts for a week or more and may be excessive to such an extent as to incapacitate the patient and actually render her anæmic. Examination of the pelvis finds the pelvic organs entirely normal so far as bimanual palpation can explore them. Drug treatment is without any effect whatever, while curettage, which is inevitably done sooner or later, at best has no more than a transient effect. In some patients the operation may cause an increase in the bleeding.

Recent investigation of these patients has done a little to

show the causes of functional menorrhagia, and has made it possible to define at least three types. The first, or *hyperthyroid* variety, is a recognizable clinical entity. Measurements of the basal metabolism of these patients have shown that many of them have an increased metabolic rate ranging from about + 18% to + 30%, indicating an excess of thyroid activity. The condition is separate from that of toxic goitre inasmuch as there is usually no obvious thyroid enlargement or exophthalmos, though most patients have lost weight or are thin, and are of a hyperexcitable temperament, commonly known as "nervous." They sleep badly or fitfully, are liable to unreasonable anxieties, and are generally unstable. Occasionally there is an increased tendency to sweating and tremors of the hands. There are almost all gradations between this condition and ordinary toxic goitre. But of all the symptoms, the most conspicuous is intractable menorrhagia, and any others are usually ascribed by the patient to the effect of severe losses of blood.

In conjunction with C. M. Wilson the writer investigated the thyroid condition of these patients and found that in nearly all the metabolic rate was raised to a pathological degree. Acting on this indication we have treated about thirty-five positive thyroid cases by X-rays applied to the thyroid gland for six to ten doses, with the result that a certain proportion have been entirely cured of their menorrhagia without any local treatment whatever. About an equal number, however, have received no benefit. An examination of the results shows that the more obvious is the hyperthyroidism, both clinically and by the basal metabolic test, the more likely is a cure to be effected. For example, a young woman who has been losing flesh with a slight enlargement of the thyroid and a B.M.R. above 25% will almost certainly be cured of menorrhagia, and also relieved of the other symptoms of hyperthyroidism. But a patient who has had little, if any, of the clinical manifestations of

hyperthyroidism with a B.M.R. of only + 16% will probably be unaffected by X-ray treatment of the thyroid. For a detailed account of the meaning and estimation of the basal metabolic rate, the reader is referred to " Recent Advances in Medicine " by Beaumont and Dodds.

A second type of functional menorrhagia is almost certainly caused by excessive hormonic activity of the ovary. We know that an ovarian secretion is responsible for the initiation and maintenance of the function of menstruation, and it is a reasonable hypothesis that excess or aberration of this form of ovarian activity should induce an excessive menstruation. The theory is here only partly stated, for no mention is made of the interaction of other endocrine glands such as the thyroid, and this almost certainly occurs, but the exact mechanism of this interplay is still unknown to us. Evidence of the ovarian influence in the direction of excess is furnished by the action of radium introduced into the uterine cavity. A sufficiently long exposure to the action of radium will induce the menopause by causing atrophy of the ovary, while a lesser dose will produce a temporary amenorrhœa or a diminution of the menstrual flow. Here we have evidence that a case of functional menorrhagia, cured by radium, has been relieved by the damping down of ovarian activity.

The therapeutic use of radium for this condition has been described by Blacker (17). He describes treatment of hæmorrhage at the menopause and also that of young adults. In his series there were thirty-four women at the age of the menopause, in whom complete amenorrhœa resulted. In fifteen the amenorrhœa followed immediately, while in eleven after the occurrence of one period, and in seven after two or more periods. The average dose used was 2,000–2,400 millicuries (see Chap. XIV), the lowest being 1,200 and the highest 3,280 millicuries. In some cases an external application of radium to the hypogastrium was also made. Blacker describes eleven cases of functional menorrhagia between

twenty-two and forty-two years of age. In six, complete amenorrhœa resulted after one or more periods ; in three, the hæmorrhage has been successfully controlled, while two have undergone hysterectomy at a later date.

Similar work has also been done by Forsdike (18), who quotes the results of radium treatment of sixty-five cases. His youngest patients, who were eighteen and nineteen years, were first seen in a blanched condition. They were treated by 50 mg. of radium sulphate for twenty-four hours, which produced complete amenorrhœa. Five other cases below twenty-six received 50 mg. of radium sulphate for varying times of five to ten hours. In four of these women the menstrual period was not abolished, but reduced to normal proportions.

Forsdike maintains that the action of radium is not on the ovary but on the uterine mucosa. He has examined cats' ovaries placed by suture at 8 cm. from a radium tube contained in the horn of the uterus, and claims that the endometrium in contact with the radium container shows varying degrees of atrophy with an increase of connective tissue element and decrease of capillaries, glands and stroma cells. On the other hand, the ovary at 8 cm. distance showed no demonstrable changes. The experiments were repeated with the ovary fixed at 4 cm. distance from the radium contained in the uterus, but again no histological changes were noticed in it. Forsdike admits, however, that the ovary which was attached close to the uterine horn containing radium showed destruction of the specific elements of the ovary such as Graafian follicles and corpora lutea. It is known that the ovary is extremely radio-sensitive, as illustrated by this latter observation, and it is obviously possible for therapeutic intra-uterine radiation to affect the ovary seriously if the dose of radium used is either too large or too prolonged.

The ideal to aim at in the treatment of functional menorrhagia by radium is a return to the normal degree of menstrua-

tion. Though the patient may be relieved of her menorrhagia it is undesirable to produce complete amenorrhœa, for with it certain menopausal symptoms commonly make their appearance. How far this is likely to disappear in the course of years and be followed by the re-establishment of normal menstruation and power of conception it is impossible to say, but it is certain that menopausal symptoms may follow radium treatment during the immediate future. While too large a dose may produce menopausal symptoms, too small a dose may be followed by an increase in the bleeding. It is most important, therefore, in radium therapy of functional menorrhagia in young women to use the correct dosage.

A strong contra-indication of all radium treatment for pelvic conditions is the presence of pelvic inflammation, either acute or chronic. The effect of radiation on salpingitis, for example, is to stir up the infection with the production of acute symptoms and abscess formation.

Toxic Menorrhagia.—A third form of functional menorrhagia is undoubtedly of toxic origin. Again, no pelvic lesion may be present, the patient is often a young nullipara and curettage has been without effect. In addition to menorrhagia the patient may appear to be " toxic " from her colour, lassitude and loss of flesh. Careful search may reveal a chronic intestinal stasis with ulcerative colitis, a coli bacilluria, pyorrhœa or some other form of chronic infection. Treatment of such a focus of sepsis is frequently followed by a complete cure of menorrhagia.

It is probable that other types of essential menorrhagia will be defined on a pathological basis as further investigation reveals more clearly the physiology of the genital organs and ductless glands.

Salpingitis. Plastic surgery of the Fallopian tube and possible cure of sterility are referred to in Chapter X. In addition to an extension of conservative and reconstructive methods for cases of old fimbrial adhesions or " sealed tubes "

there have been reconsiderations of the proper treatment of acute suppurative salpingitis.

For many years the general view of this form of acute salpingitis has been that it is in the great majority all cases of a condition to be treated by purely medical measures, inasmuch as they are nearly always successful in averting general peritonitis. In other words, the cases "settle down" by being limited to an acute pelvic peritonitis only, without immediate danger to life. The recovery of the patient from her acute and potentially dangerous symptoms, without any regard for the chronic condition remaining, has been, and still is regarded by many gynæcologists, as sufficient justification for so-called expectant treatment. It must be recognised, however, that there are after-results of acute suppurative salpingitis, however complete may be the apparent resolution by medical treatment. Fimbrial adhesions sealing the tube and thereby causing sterility are almost inevitable, while the probability of the formation of a chronic tubal pus sac, or interstitial salpingo-oöphoritis is also very great. At the Portsmouth meeting of the British Medical Association in 1923 the writer, in opening a discussion on the treatment of acute suppurative salpingitis made a plea for early operation in all cases of acute salpingitis of sufficient severity to make it clear that the tubes contained pus (19). The reasons advanced for operation were chiefly the advisability for preserving, if possible, the function of the tube and also to prevent the almost inevitable chronic tubal disease which is so serious a cause of pelvic pain and invalidism. In addition, it is no small matter that in the more serious cases the convalescence is shorter after surgical treatment. To achieve these ends the writer recommended either salpingostomy or salpingectomy according to the condition of the tube. If the tubal condition does not appear to be beyond resolution and repair, it is sufficient to slit it up through the ampulla as far as possible into the isthmus, on the surface opposite to the mesosalpinx. This will convert the tube into an open

gutter, free to drain into the pelvic cavity, while the free bleeding from the cut edges relieves congestion and assists resolution. The opening of the tube will effectually prevent any possibility whatever of pyosalpinx, while the absence of pent-up irritating discharges within the lumen of the tube will also save the tube wall from interstitial salpingitis.

That complete resolution can occur after salpingostomy was demonstrated at an autopsy made by the writer on a woman on whom the operation had been done some six weeks previously. The tubes were found to be entirely resolved, gutter shaped, and lying freely open in the pelvic cavity with apparently normal mucous membrane.

While it seems certain that further disease due to incarceration of pus or sero-pus in the sealed tube can be prevented by this simple measure of slitting the tubes, there is also hope that the preservation of the tube even in the form of an open gutter may enable conception to occur. So long as there is any prospect of the tubes resuming their function it is worth while leaving them, provided that the future formation of pyosalpinx has been prevented by the complete slitting up of the ampulla. If, however, the tube at operation shows signs of local gangrene or ulceration of its mucosa, or any condition which indicates that functional resolution will be an impossibility, then the tube should be entirely removed. It is obviously useless to leave a tube which cannot carry out its one function of conveying the ovum. Should this already be lost there can be no deprivation to the woman, but certain safeguarding from chronic pelvic disease, by removing the tube.

The writer feels, therefore, that there should be some form of active treatment for acute suppurative salpingitis, and not merely "expectant" treatment, which can do little or nothing except assist the acute symptoms to subside. Active treatment in the shape of laparotomy as early as possible should comprise either the conservative measure of salpingostomy

if there appears to be a chance of resolution or salpingectomy if the tube is beyond hope of repair.

The Ductless Glands.—The use of endocrine gland therapy in gynæcology has not made any real advance during the last few years; indeed, it is difficult to point to any purely gynæcological condition for which there is scientific evidence that this form of treatment is of any value.

Very much scientific work has been done on the physiology of the ductless glands, and many attempts have been made to apply the results to the treatment of disease, but perhaps in no branch of medicine has there been greater disappointment. The absence of scientific sanction, or even positive scientific proof of ineffectiveness has not, however, prevented an orgy of empirical treatment of all manner of diseases by endocrine extracts. We have a few proved remedies of real and scientific power, such as insulin from the pancreas, suprarenal, pituitary, and thyroid extracts. These bodies have definite indications and produce constant and definite results when used for their proper purposes. But "extracts" have been prepared from almost every other organ in the body, and are given for almost every variety of disease, either singly or in various innumerable combinations, irrespective of whether there is any supporting scientific evidence. A race of physicians has grown up known as "endocrinologists" whose skill and ingenuity in formulating different endocrine mixtures, accurately fitting the requirements of various "syndromes," almost compels our admiration. They turn not, however, to the pharmacological laboratory, but to the manufacturing chemical firms for their inspiration. Here we see a reversal of the rule of economics that the demand creates the supply. Our enterprising manufacturers not only supply the "extracts" but also a spurious form of medicine text-books tastefully published in elegant brochures, deeply disguising their real purpose of advertisement. These publications describe a new system of clinical medicine artfully set forth to show an endocrine disorder as the root cause,

followed immediately by a " treatment " consisting of a suitable combination of two or more extracts. There seems no limit to the " pluriglandular " permutations. They are not yet exhausted, and there is still scope for the treatment of many more familiar disorders. The presumption to teach clinical medicine to practitioners by the manufacturing firms by means of their " text-books," all directed to stimulate the purchase of their products and obviously for no other reason, is naturally resented. It is degrading to medicine, and, by so closely linking it to commercial exploitation, is separating it still further from exact science on which it should rest.

Perhaps no branch of medicine is more the victim of the manufacturers than gynæcology, and in no department is there less real sanction for the use of endocrine extracts. Empirical administration will usually end in disappointment, even though a case here and there may apparently be benefited. As Swale Vincent quotes : " It is a poor cure that will not find its lucky patients." All the real advances in endocrine therapy have emanated from work done in the laboratory. Such examples are insulin, adrenalin, and pituitary extract, the fruit of long and laborious experiment carried on by trained scientific observers. It is unlikely that work of any value whatever can originate from the indiscriminate and uncontrolled use of ductless extracts in clinical practice, at the behest of commercial firms.

Clinical observation of gynæcological diseases treated empirically by endocrine extracts scarcely furnishes sufficient opportunity for correct judgment. These diseases are chiefly disorders of menstruation and sterility, conditions which are notoriously capricious, both in their onset and disappearance, and almost infinite in their variety. Before an opinion of any value can be formed, it is necessary to observe a large number of identical cases treated by identical methods and controlled by a suitable number of similar cases without treatment. Such a procedure is almost impossible in clinical practice, especially where observation is hampered by the

existence of subjective symptoms as the main expression of the disease, and also by an inevitable and unconscious bias on the part of the observer. Finally, it is obvious that the preparation used should contain some potent principle, some essential and specific element peculiar to that special gland. It is doubtful how far these principles can be isolated or preserved even when the organ extracted actually contains them. Still more is it doubtful if the ordinary means of administration, by mouth, allows of the absorption of the active principle into the blood stream. In the case of thyroid extract we know that it is absorbed when given by mouth, but whether ovarian, testicular, and many other preparations can be absorbed is very doubtful. Is there any gynæcological condition proved to be of endocrine origin which can be successfully treated by administration of an extract of the affected gland ?

Myxœdema is caused by a deficiency of thyroid activity, and when this is made good by administration of thyroid extract the symptoms disappear. Here we have an instance of a definite disease treated by its proved remedy with the certainty of improvement and sometimes of cure. But there are few, if any, other conditions in gynæcology of endocrine origin which can be successfully treated by substitution of an artificial extract for the natural deficiency. Menopausal conditions, presumably due to ovarian atrophy with consequent loss of its internal secretion, cannot be mitigated by taking ovarian extracts. Indeed, there is no unequivocal evidence that ovarian extracts are of any benefit whatever in any condition. The very preservation of the active principle during the process of extraction, or its absorption from the intestine, if preserved, are both doubtful. Ovarian extracts are probably the least satisfactory of any of the endocrine products. The ovary is a complex body consisting of at least three different cellular elements which are present in a varying degree. Little is known of the relative importance of the hormonic contributions of each of these elements,

and, therefore, any two preparations of ovarian extract may vary considerably in composition, if, indeed, any of them possess any potency! The *corpus luteum* is now extracted separately, and is credited with powers which change, as sufficient time has passed to prove its uselessness for any one "indication." A few years ago it was a specific for pregnancy vomiting. Now it is equally a specific for sterility. As an example of "indications" for the use of *corpus luteum* one recent commercial publication recommends it for delayed or scanty menstruation, dysmenorrhœa, pernicious vomiting in pregnancy, sterility, habitual abortion, menopause, pruritus vulvæ, kraurosis vulvæ, menorrhagia and metrorrhagia (due to "hyperactivity of the ovary")—a veritable gynæcological potpourri! But perhaps the extravagances of endocrine therapy are seen at their worst in the use of "pluriglandular" preparations. Here the most enthusiastic "endocrinologist" will find ample backing by the manufacturing firms. An example is an advertisement of sixteen varieties of pluriglandular preparations containing various mixtures of gland and other extracts, including "brain extract for 'nervous debility'"! We have only to wait for muscle extract for muscular debility!

Considering the doubtful value of oral administration of any glandular extracts except thyroid, it is probable that this is the only product of any real therapeutic value in gynæcology. We know the close association between the thyroid and pelvic viscera from both experimental and clinical evidence, and, therefore, there is a sanction for the use of the extract in certain gynæcological conditions where a thyroid deficiency is known. Myxœdema with amenorrhœa has already been mentioned, but it is possible that some other conditions of imperfectly developed or functioning uterus, not associated with the other symptoms of myxœdema, may also be remedied by the use of thyroid extract. Spasmodic dysmenorrhœa, scanty menstruation, delayed puberty and sterility are all symptoms of pelvic hypoplasia, and may

therefore be legitimately treated by thyroid extract, as we are giving a compound which we know exists in sufficient amount in the tablet administered we know it is absorbed, and we also know that these conditions are associated with hypothyroidism. It is probable, however, that any good results will only be obtained in young patients, *i.e.*, adolescent or those below twenty-six years.

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CHAPTER X

STERILITY

Interest in the causes of sterility has been stimulated during recent years by the use of a new method for investigating the patency of the Fallopian tubes, by vaginal examination. While it has been known that patent tubes are a *sine qua non* for the occurrence of pregnancy ever since the physiology of the pelvic organs has been worked out, yet, in the clinical examination and treatment of sterility attention has generally been devoted to the condition of the uterus, particularly the cervical canal. Obstruction of the cervical canal to the passage of spermatozoa, instead of occlusion of the Fallopian tube to the passage of the ovum, is regarded as the condition to be treated, in spite of the fact that the cervical canal, though large enough to permit the escape of menstrual fluid, must be sufficiently large for the entrance of spermatozoa. Nevertheless, success has followed the operation of dilatation of the cervix often enough to justify this purely empirical line of treatment, and there is no doubt, other organs being normal, it may still be a very useful method of treatment.

Neglect of the Fallopian tube in the examination of sterility was due to the absence of physical signs of any lesion of the tube by bi-manual examination and of any method whereby obstruction could be diagnosed, apart from the palpation of a definite swelling or induration. Investigation of the tubes during laparotomy, even when normal in appearance, by passing a bristle down the lumen or injecting saline along the tube by a syringe applied to the abdominal ostium, showed that obstruction of the channel could exist even

though no obvious abnormality could be seen or felt. Further, it was observed that frequently the ostium is blocked or sealed by fine filmy adhesions, far too delicate to be appreciated by bi-manual examination. Further, it also has been noticed that such delicate incapacitating adhesions of the fimbriæ can exist in the absence of any history of pelvic inflammation or other obvious signs of old gonorrhœa. Gradually, therefore, it has been recognised that the cause of many cases of sterility in women is the obstruction of the tubes rather than an abnormal condition of the uterus. As a means of diagnosis of the tubal condition a great step forward has been made by the use of an apparatus which can detect the presence of an obstruction in the tube by vaginal examination. The principle of the new method of examination of the tubes depends upon the injection of gas through the internal os into the uterine cavity under a known pressure. Should the Fallopian tubes be patent the injected gas will slowly pass through the uterine ostia, along the tube, and into the peritoneal cavity. If, on the other hand, the tubes are impermeable, gas will fail to pass. The method was first devised by Rubin (1), and was introduced to British gynæcologists at the Portsmouth meeting of the British Medical Association in 1922 by Gilman Currier of New York. On that occasion he demonstrated an apparatus of his own design (an illustration of which is figured on p. 232) and gave an account of its possibilities of diagnosis.

Many modifications of this apparatus have been introduced since Currier's visit, chiefly in the direction of simplicity. The extreme limit in this direction has been reached in the use of a Higginson's syringe attached to a hollow dilator, which is introduced through the internal os, as described by Victor Bonney (2)—I will reserve, however, comments on modifications until after the Currier's apparatus has been described. In brief, this consists in the use of carbon dioxide supplied by a sparklet bulb—the same as used for the production of soda water. A length of pressure tubing

passes from this to the manometer (either of the mercury or dial variety) to an inverted bell standing in a jar of water. The bell has a capacity of 50 c.c. From the jar a further length of pressure tubing passes direct to a hollow uterine sound ; the apparatus provides for the generation of the gas

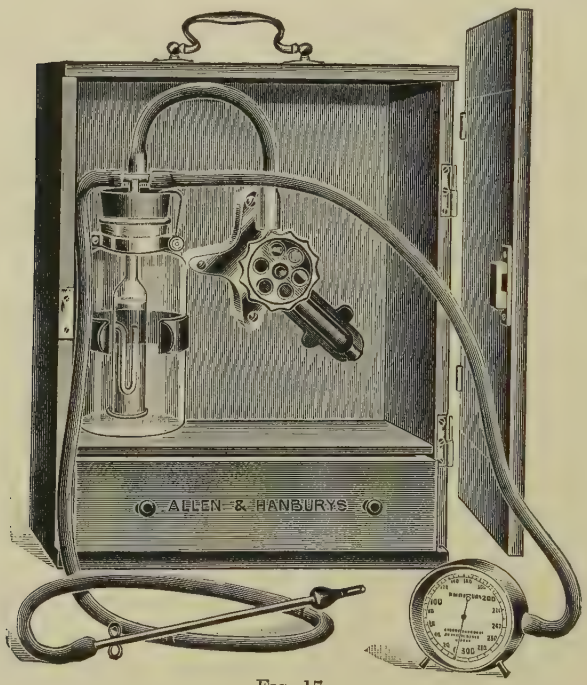

Fig. 17.

under pressure, a manometer for the measurement of this pressure, and the inverted glass bell in water, by which the amount of gas passing can easily be measured. The passage of the gas is controlled by convenient taps. The uterine portion of the apparatus in the original form was a simple hollow uterine sound provided by a rubber acorn situated about 2 in. from the top of the sound, and so shaped as to be adapted to the external os ; pressure of the acorn against the

os should be sufficient when the gas is passing to prevent a back leakage.

In the modified apparatus used by the writer a hollow Hegar's dilator is used of size No. 10—that is sufficiently large to excite considerable pressure by the internal os which effectually prevents any leakage.

The use of the apparatus is extremely simple—the patient is anæsthetised (Rubin never uses an anæsthetic) and prepared as for the operation of curettage, the apparatus is prepared by fixing and screwing home the sparklet, all the taps being closed. Sufficient water has already been placed in the jar to cover the shoulder of the bell. Hegar's dilators are then passed until No. 9 is reached, after which the special hollow dilator, attached to the apparatus by its rubber tubing, is introduced into the uterine cavity. When this is being done the internal os will be found to grip the dilator sufficiently tightly to prevent any leakage. The taps are then gradually turned on to allow a slow escape of gas from the sparklet, which will immediately depress the level of the water in the bell until the latter is entirely full of gas, and the water completely displaced. When this has occurred 50 c.c. of gas have passed and the manometer will be observed slowly rising. An assistant then takes a stethoscope and listens over both iliac fossæ for signs of the escape of gas through the abdominal ostia. If the Fallopian tubes are patent the pressure shown by the manometer will rise to from 60 to 100 mm., at which level it will remain stationary so long as the escape of gas is fairly slow ; that is, not more than 50 c.c. in one minute. Occasionally the pressure at first may rise to 100 c.c. or even more, after which it will quickly drop back to the region of 60 or 80 mm., at which level it will remain. During the time that the gas is passing the stethoscope will reveal fine bubbling noises as it is escaping from the ostia—this sound is quite characteristic, and when once heard is readily appreciated for what it is. Rubin always uses X-rays to confirm the presence of pneumo-

peritoneum. If one tube only is patent the pressure necessary for the passage of gas is higher, and will probably be in the neighbourhood of 100 or 120 mm., while the stethoscope will only detect the sound of gas escaping on one or other side of the hypogastrium. Occasionally, if the tubes are diseased or markedly congested, as just before menstruation, the gas may pass with difficulty, and therefore requires a higher pressure. If both Fallopian tubes are entirely occluded, the pressure will steadily rise as long as the gas is passed to a limit of safety at about 200 mm. It is stated by Currier that there is a danger of rupturing the tube at a pressure of 250 mm., but this must be a very rare event, and has not yet occurred in the writer's experience. Occasionally the pressure may reach a high figure, such as 180 mm., and then suddenly drop back to 60 or 80 mm. If leakage can be eliminated, this behaviour of the manometer indicates that the obstructing adhesion has been sufficiently light to break down under this pressure. When this occurs the apparatus has not only been of diagnostic value, but has also proved of therapeutic use. The dangers of the apparatus are very few and can easily be guarded against. The first objection realised by all who see it for the first time is that it may be the means of conveying septic cervical discharges into the uterine cavity and along the tubes, with the risk of setting up peritonitis. It is obvious that every possible precaution against this danger must be taken in the shape of thorough disinfection of the vaginal canal and external os by means of iodine. It should not be used in the presence of an obvious cervical discharge without preliminary disinfection of the vaginal canal for a week or two beforehand, nor, of course, should it be used soon after an attack of acute pelvic inflammation. It must not be used either during or just before menstruation, nor in the presence of any serious general disease. In spite of the theoretical possibility of conveying septic material into the peritoneum, the practical danger, with due precautions, scarcely exists, and in the experience

of the writer and others who have used this or similar forms of apparatus, no case of infection has occurred.

The risk of rupture of the tube does not occur if the pressure does not exceed 200 mm., and should there be a pyosalpinx with friable walls there will be sufficient occlusion of the interstitial or isthmial portions of the tube effectually to prevent any passage of the gas into the pus sac. Every care, however, should be taken to avoid using the instrument if palpable tubal swellings are present.

There are no unpleasant after-effects, except occasionally a little pain felt in the right shoulder, and this depends upon the amount of gas introduced. The pain is caused by the bubble of gas free in the peritoneal cavity rising to lie beneath the diaphragm, and in this position it irritates the nerve endings of the phrenic nerve, thus causing referred pain in the shoulder. If the amount of gas injected is not more than 50 or 100 c.c., it is absorbed quickly enough to have disappeared by the time the patient awakens from the anæsthetic—in any case, it is only a slight and transient discomfort. An anæsthetic is not necessary if a narrow uterine sound is used instead of a hollow No. 10 dilator. The patient will experience discomfort without an anæsthetic when the cervix is grasped by the volsellum, and there will also be discomfort if the pressure in the uterus and tubes rise above 150 mm., which will be felt as a pain in the lower abdomen, but there is little or no discomfort if gas passes easily through the tubes until it has floated up to the diaphragm.

The writer has always, so far, used an anæsthetic because, apart from a disinclination to inflict discomfort or pain, it is a much easier operation to carry out if the patient is anæsthetised, and at the same time a more thorough bi-manual examination of the pelvis can be effected.

Clinical Uses of the Inflation Apparatus

The chief and primary use of this apparatus is for the diagnosis of occlusion of the tubes. Its chief value here lies

in its ability to discover an obstruction in the absence of physical signs.

As I have already mentioned above, there are large numbers of cases in which the tube on one or both sides is entirely occluded without there being any possibility of bi-manual diagnosis, and it is precisely in this type of case that the instrument has its chief value.

When these patients are met with they are usually assumed to require simple dilation and curettage, but it is quite obvious that this operation can be of no value if there is tubal obstruction present, as the true cause of sterility. It is well, therefore, to explain the possibilities to the patient and while dilation is being carried out to test the patentcy of the tubes by the use of this apparatus. If they are patent, nothing more than dilation is required, but if they are impermeable it is obvious that some form of plastic operation on the tubes is necessary.

Many women will not give their consent to a laparotomy for sterility under a condition in which we cannot guarantee a favourable result, but there are a few who are anxious to explore every possible means for rendering conception and pregnancy possible. For those patients who refuse laparotomy, nothing more, of course, can be done, but to those who are willing it should be explained that the operation on the tube amounts to either restoring the patentcy of the tube by injection of a saline or passing of a bristle, or, if this cannot be done, the making of a new ostium on the uterine side of the obstruction.

It is difficult to answer the patient's inevitable question as to the chances of a future pregnancy, but it can be stated that this largely depends upon the condition of the tubal mucous membrane which is discovered during the operation. Should the tube appear to be perfectly normal, except for fimbrial adhesions, the chances of pregnancy ensuing after a new ostium has been made are very good, but if the tube is damaged to a serious extent, or contains thin sero-pus, or has

an obstruction in the isthmial region, then the chance of a successful result is very poor.

L. G. Phillips (3) recently published a series of cases of plastic work on the tubes which was followed by pregnancy in 25% of the cases within three years. The operations which he practised varied from simple salpingostomy to rather more elaborate procedures, such as excision of the obstructed portion of the tube and burial of the ampullary end into the uterine wall. In his series no pregnancies followed this latter operation.

In addition to diagnosis, the instrument also has a therapeutic value inasmuch as small or delicate obstruction of the tube can be broken down by a pressure of about 150 mm. This can be observed during the operation by noting the sudden drop of pressure which may follow a steady mounting of the manometer up to, or even above, 150 mm. Such a sudden drop is due to the pressure breaking the adhesion down and allowing the gas easily to pass.

Curative Value of Tubal Insufflation

Rubin has recently drawn attention to the value of tubal insufflation as an actual cure of sterility. He communicated to the New York State Medical Association in May, 1925, that out of 1,000 consecutive patients insufflated ninety-five had subsequently become pregnant. As these women reported voluntarily, it is probable that a systematic questionaire would have discovered a greater number.

Of a total of 101 pregnancies in Rubin's series twenty-one had been married between five and fifteen years, and sixty-one had been married between one and three years. Coincidence must, of course, play a part in all these cases, especially where the maximum pressure does not exceed 100 mm., but sterile marriage for five years is a fairly rigid criterion to apply, and it is therefore justifiable to assume that most of the twenty-one cases of pregnancy were rendered possible by insufflation.

Modifications of the Apparatus.—The chief modifications employed are in the direction of simplicity. Bonney has recently published a description of the apparatus he uses, which consists of a rubber bulb, manipulated by the hand, attached to a hollow dilator. There is no manometer or provision for measuring the exact amount of gas injected, but the pressure is roughly ascertained by noting the resistance of the bulb to hand pressure. Bonney (2) states that this is a perfectly reliable method in his hands, and that he is able to estimate the pressure sufficiently accurately for the purposes of diagnosis. Other writers also have stated that they find this simple method sufficiently reliable, but in the writer's opinion the use of a manometer seems to be a great convenience in giving exact information, while at the same time it is so simple an addition to the apparatus, that it can scarcely be accused of complexity.

With regard to the jar of water which measures the volume of the gas injected, and also its rate of passage into the uterus, this is strictly unnecessary; but at the same time one feels much greater confidence in using an instrument if before one's eye there is an obvious indication of the measure of the gas, and the rate of its injection.

A simple modification of the original apparatus is the use of a hollow dilator instead of a hollow sound (Bonney), for induction into the uterus. The sound fitted with the rubber acorn for pressure against the external os to prevent leakage has the single advantage that the os need not be dilated, and therefore an anæsthetic need not be given; but at the same time, leakage is difficult to prevent except by a very firm pressure, and this is particularly difficult to prevent if the margin of the external os is irregular from previous birth lacerations.

If an anæsthetic is used and dilation, or thorough bi-manual examination are required, the use of a hollow dilator is much more satisfactory.

Further Development of Inflation Diagnosis.—Forsdike (4),

and Williams and Reynolds (5) have recently attempted to diagnose not only the presence of an obstruction in the tube, but also its exact site. The principle of their method is the injection of an opaque barium emulsion or lipiodol into the uterine cavity, relying on the known tendency of fluids in the uterine cavity to pass backwards along the tubes and into the peritoneal cavity. The patient is X-rayed at a suitable interval after the injection, and the position and shape of the tubal shadow is carefully noted. Where no obstruction exists the whole of the tube is opaque, and in addition, there is a shadow cast by a small quantity of fluid lying in the bottom of the pouch of Douglas. The presence of this shadow proves that the whole of the tube is patent, but if the shadow stops short or shows a constriction at any one site of the tube, it is inferred that obstruction exists at this point. This very ingenious method of diagnosis has the great disadvantage of complexity. In addition to the injection of the emulsion, there is required an X-ray photograph which may have to be repeated. In hospital practice there is no great disadvantage here, but in private practice obvious difficulties arise.

A further difficulty is the interpretation of the photograph ; in a few well-chosen cases the photographs are clear and strikingly obvious, but in others there must be an element of considerable doubt as to the meaning of the shadows. The advantage of knowing, however, where the obstruction lies is that operation may be of value in some cases, but useless in others. For example, if the shadow shows only a fimbrial adhesion, operation is well worth while, but if the isthmus is blocked, little can be done, and it is doubtful whether operation is justifiable. The radiographical method, therefore, has this *raison d'être*, that if it is further developed and proved of real diagnostic value, it will be able to effect a discrimination between those cases which should be operated upon and those which should be left alone.

The methods of examination of the Fallopian tube are

comparatively new, but the simpler processes have been thoroughly tested and are of proved value.

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CHAPTER XI

ENDOMETRIOMA OF THE OVARY

Hæmatoma of the ovary is a condition which is well known. It has long been recognised as a possible result of torsion of the pedicle of an ovarian cyst or hæmorrhage into a Graafian follicle, but another important variety has been described and confirmed in its pathology by Sampson in 1921 (1). Discussion has raged round the true nature of uterine adenomyoma since its epithelio-muscular structure was first described by Cullen in 1896, but it is only by the work of Sampson on the ovarian hæmatoma that the true nature and close relationship of both these conditions have been definitely established. Further work has been done on the ovarian hæmatoma, now known as the " chocolate cyst " or endometrioma, by Blair Bell (2), Shaw and Addis (3), Donald (4), and Bailey (5), who have defined not only a circumscribed pathological condition, but also a definite clinical condition with its appropriate diagnosis and treatment.

This tumour, variously known as a " perforating hæmorrhagic cyst of the ovary " (Sampson), " chocolate cyst " and " endometrioma " (Blair Bell), we shall refer to throughout by the last name, as it most truly describes its true pathological nature and origin. The chief features of the tumour are that it forms a cyst of the ovary, often bilateral, containing a fluid looking like " chocolate syrup." The cyst rarely attains a size greater than 2 in. (5 cm.) in diameter, and is usually very densely adherent to the structures in the lowest part of the pouch of Douglas. Hitherto, the density of the adhesions has been the most conspicuous feature

during operation, and has often led to a diagnosis of previous severe salpingitis, or even malignant disease of the ovary. Further examination of the pelvis may show that tumour formation is not limited to the ovary. It is possible that hæmorrhagic areas or nodules, according to the organ or tissue in which they occur, may be noted on the posterior uterine wall, the pelvic peritoneum, the round ligament, or the depths of the pouch of Douglas. An exaggeration of one of these extra-ovarian tumours sometimes occurs, forming a mass overshadowing the small cyst in the ovary. An example of such is the true adenomyoma of the uterus of non-muscosal origin or the similar tumour found occasionally in the recto-vaginal septum. All these tumours, apparently so different in their nature, have now been shown to be of the same essential origin. The ovarian endometrioma is a small cyst having thick walls which do not collapse after the rupture of the cyst, and is of a bluish colour. It is usually very densely adherent to the posterior wall of the uterus or rectum, and the act of separation of this adhesion invariably ruptures the cyst at the point of attachment. There is a small raw area at this point, and around the rupture the wall is quite thin. The cyst is lined either with a brown shaggy membrane suggesting fragments of old blood clot, or else is smooth and grey, with small brown or red patches. The larger cysts may have more than one loculus. The essential nature of the tumour, however, can only be demonstrated by microscopical examination of the wall of the cyst. According to its size, its epithelium is columnar, cubical or flattened, but the characteristic feature is that here and there in the wall of the cyst are to be found clumps of cells indistinguishable from the endometrium of the uterine cavity. In the oldest and largest cysts this specific tissue will have died out, leaving little trace of its true structure, but in the smaller and growing cysts the occurrence of small masses of endometrium-like tissue is unmistakable. It is this discovery of aberrant endometrial tissue which

imparts the great pathological interest to these tumours. Much speculation has centred round the origin of this tissue in the ovary and pelvic peritoneum. Sampson and others believed it was derived from endometrial elements scattered on the surface of the ovary or in its periphery, which, under some unknown influence, developed an " invasive " property with powers of continued local growth. Others have endowed the surface epithelium of the ovary with metaplastic power, whereby normal ovarian epithelium has taken on the appearance of endometrial cells, producing glands by a down-growth or invagination. These theories have difficulty, however, in explaining the " menstrual " function of the endometrial islets, for it is by this function that the blood forming the cyst is poured out. Moreover, sections taken during menstruation show the typical changes in the islets and cysts as are found in the uterine cavity. The tissue, therefore, is not only endometrial in morphology, but also in function, and this latter property is difficult to account for on the theory of metaplasia.

Another view, well substantiated by microscopical observations, has been put forward by K. V. Bailey (6) which explains not only the origin of the endometrial islets in the ovary but also the coincident tumours in the uterus and other parts of the peritoneal cavity. He has observed that during menstruation there may be some regurgitation of menstrual fluid and exfoliated flakes of endometrium from the uterine cavity along the Fallopian tubes into the pelvic cavity. Serial sections of the tube, including the interstitial and isthmic portions removed during menstruation, without clamps, have shown the lumen to contain blood and endometrial elements. It is conceivable that blood in the tubal lumen was derived from its own mucosa by a process of tubal menstruation, but this latter process has not been observed to occur in spite of much histological search for evidence. It seems clear, therefore, that it is possible for blood to regurgitate along the tubal lumen during menstruation, but

how far this is a normal or constant process it is impossible to say.

The stages in the formation of ovarian endometrioma after the migration of endometrial tissue along the tube have been very clearly described and illustrated by K. V. Bailey. He has studied twenty cases of this and allied tumours, and by

Fig. 18.—Right ovary, low power. Two small endometrial gland spaces in fine fibrin network, with scattered endometrial stroma cells situated on the surface of the right ovary. Invasion has not yet commenced. (Bailey.)

study of serial sections has worked out the following stages of development :—

Stage 1.—The menstrual blood from the uterus carrying small fragments of endometrium escapes from the fimbriated extremity of the tube and is deposited on the ovary, Fig. 18. It is not possible to observe this earliest stage by the naked eye, but sections have been obtained by Bailey showing these small fragments adhering to the ovary. This observation, together with that of endometrium in the Fallopian tube,

proves satisfactorily that the deposits have been derived from the uterine cavity and have nothing to do with modified or metaplastic ovarian germinal epithelium.

Stage 2.—The remarkable and as yet unexplained property of the deposited fragment is the power of invasion of the ovarian substance, Fig. 19. Whether all such fragments possess this power is unknown. If it were so, we should expect very many more women to suffer from this form of tumour. There may be some occasional and unknown

Fig. 19.—Right ovary. Deposit of typical endometrial tissue beginning to invade ovarian stroma. The formation of a small excavation. (Bailey.)

stimulus to growth imparted by the ovary on to which the fragment falls ; but whatever may be the cause, we know that the fragment may have the power of sustained growth and invasion, probably by means of cytolytic ferments digesting the ovarian substance.

The second stage is characterised by this commencing invasion. It may be visible to the naked eye as a small hæmorrhagic spot or area on the surface of the ovary. The microscope shows a minute excavation of the surface of the ovary containing dark blood, or the undermining of the edges of the minute hole which was the primary entrance of the

endometrial fragment into the ovarian stroma. By this time the ectopic fragment will have menstruated. This is the source of the dark blood filling the cavity, which later on will collect in sufficient quantity to form a small blood cavity. Microscopically the invading fragments can be seen in the

FIG. 20.—Right ovary, low power. Wedge-shaped formation of invading endometrial glands and stroma actively menstruating. (Bailey.)

actively menstruating condition of the uterine endometrium if the ovary happens to be removed during menstruation.

Stage 3.—Proliferation of the invading endometrium has taken place sufficiently to form a wedge-shaped mass of tissue having its base on the surface of the ovary and its apex deep in its substance, Fig. 20. The growing and penetrating apex consists of endometrial stroma cells. Menstruation by the fragment has caused bleeding around it which has infiltrated and separated the cells of the ovarian stroma, forming a dark zone around the endometrium. The blood is dark, but

not yet chocolate coloured, as sufficient time has not yet elapsed. At this time the ovary is always adherent at the area of invasion to some neighbouring peritoneal surface, usually the back of the uterus or broad ligament.

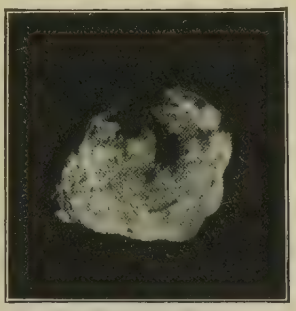

Fig. 21.—Right ovary. Transverse section in the direction of the line of growth showing "seam" of chocolate-coloured blood entering the ovarian stroma. No cavity formation. (Bailey.)

Stage 4.—The great activity of the endometrium during the last stage now begins to slow down. A section of the affected ovary now has the appearance of containing a chocolate-coloured seam "running down from the ovarian surface into the ovary itself, Fig. 21. The longer retention of the menstrual blood gives it the chocolate colour, but not sufficient has yet collected to form the typical cyst. The endometrial elements are most active at the apex of the seam, where the typical structure is best observed, for in the older parts of the invasion, *i.e.*, near the ovarian surface, degeneration has begun and destroyed the characteristic appearances of endometrium. Away from the apex, therefore, the seam consists of chocolate-coloured blood and cellular *débris* incapable of further eroding activity.

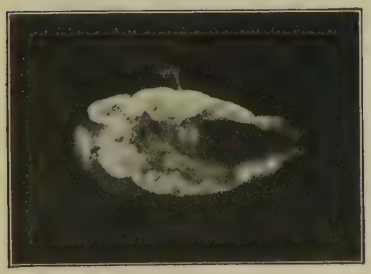

Fig. 22.—Right ovary. Section through the ovary in the direction of endometrial invasion, showing a commencing distension in the deeper part of the excavated area. Commencing cavity formation. (Bailey.)

Stage 5.—The growing apex of the seam has further invaded the ovary and continued to menstruate regularly, with the result that the increasing tension of pent-

up blood has distended that portion of the ovary already occupied by the degenerated chocolate-coloured tissue to form a blood cavity, Fig. 22. Bailey, in his paper, insists on the word "cavity" instead of "cyst" in order to express the idea that the blood space results from the excavation or "eating away" of the ovarian stroma rather than by true cyst

FIG. 23.—Left ovary. Extensive endometrial excavation of the ovary, transforming it into a distended sac containing chocolate-coloured fluid blood. The walls are formed by the thinned-out and compressed ovarian stroma. (Bailey.)

formation. One of the essential features of this tumour is the eroding and invading activity of the endometrium, which is able to destroy the whole of the ovarian substance.

Stage 6.—All further eroding activity of the endometrial invasion has now died out, the tissue has degenerated and left no trace of its true origin and structure, Fig. 23. The ovary exists as a pseudo-cyst, containing thick chocolate-coloured fluid, varying in size up to a diameter of about 2 or 3 in. (5 to 7·5 cm.). The walls of the cavity consist of thinned-out and compressed remains of the ovarian tunica and stroma. It is dark bluish-brown in colour, densely adherent, particu-

larly at one spot which was the original site of deposit and excavation.

In addition to invasion of the ovary the endometrial elements have the power of invading the uterus if deposited thereon. The result, owing to the difference of the invaded matrix, is not, at first sight, similar to the blood cavity formation of the ovary, but the principle is the same in both cases. The ectopic endometrium invades the muscular wall of the uterus, penetrating by means of the great eroding activity of the vanguard of stroma cells, the typical glandular elements following in their wake. The reaction of the uterus is a musculo-fibrous hypertrophy which with the contained endometrial elements give the appearance of an adenomyoma. One of the characteristics of this form of adenomyoma is that it has grown from the peritoneal aspect, and is independent of the mucous membrane of the uterus, in contradistinction to the ordinary type of adenomyoma, which shows on section an origin from or nexus with the mucous membrane.

It is probable that all nodules in the pelvis, including the rectogenital adenomyoma, containing endometrial tissue, have the origin and development described above, and are not, as suggested by other writers, due to endometrial " rests " or metaplasia in the pelvic cavity.

Bailey also describes a form of ovarian invasion by epithelium derived from the Fallopian tube. His theory is that fragments of tubal epithelium are mechanically detached by the regurgitant menstrual flow along the tube which we have already described. The evidence is against a true menstrual exfoliation of the Fallopian epithelium, for normally it is certain that the tube does not menstruate. In any case, tubal epithelium has been found lying upon and penetrating into the ovarian stroma, tending to produce circular forms resembling glands. There are, however, no stroma cells corresponding to the endometrial stroma, eroding activity is much less, and no large " chocolate " cysts are formed.

Penetration seldom exceeds $\frac{1}{4}$ in. (0·5 cm.) and degeneration is earlier than in the endometrial type. Blood extravasation can be noticed surrounding Fallopian invasions, but it is probable that this is derived from erosion of the ovarian capillaries, as the tubal epithelium can scarcely be credited with a menstrual activity. Bailey's work on endometrioma appears, therefore, a distinct advance on the important earlier work of Sampson, inasmuch as he has shown that the cyst is not truly a " perforating " blood cyst developed from within the ovary and rupturing externally, but that it is an invasion of the ovary from without. The point of the invasion was apparently mistaken by former investigators for a place of perforation.

Clinical Features of Endometrioma

The usual age limits are from thirty to forty-seven, the majority of patients being over thirty-eight. Below thirty the tumour is rare. Many of the patients have borne children, but usually only one or two, and there is always a period of a few years' sterility between the last child and the formation of the tumour. Nearly half the cases of any series are entirely sterile. Salpingitis plays no part in the ætiology, Sampson stating that there was no trace of any inflammatory trouble in any of his twenty-three cases. One of the chief symptoms is dysmenorrhœa of some severity. Donald (7) states that it is a constant and prominent symptom, and, coming on for the first time in middle life, is very suggestive. Dyspareunia is also commonly present. The amount of menstrual loss is variable, and there is no certain relation between endometrioma and menorrhagia. Pain is frequently present and variable in extent, but it may be absent. It is probably caused by the extensive adhesions present, but occasionally adhesions may be found on opening the abdomen when there had been no pain. In a few cases the abdomen has been opened for some other condition, when the cysts were found incidentally. Constipation has also

been described as a prominent symptom, especially if there is an adenomyoma of the rectogenital space. I have recently discovered a typical "chocolate cyst" of the ovary when operating on an intractable case of "mittelschmerz" (middle pain). The physical signs are very variable, depending upon the size of the ovarian blood cavities, and also on whether there are co-existing deposits of adenomyoma, especially the rectogenital tumour. Simple small chocolate cysts, if high up or adherent to the posterior wall of the uterus, will probably not be felt. There may be no physical sign except general tenderness in the pouch of Douglas on firm upward pressure, or some limited mobility of the uterus. If the cysts are lower down adherent to the para-rectal fossa they can be felt as firm, tender masses. The rectogenital tumour forms a tender mass above the posterior fornix, densely adherent to the cervix and rectum. The hardness and fixity strongly suggest malignant disease; indeed, this is the usual diagnosis. In early stages it may be felt as a small nodule, but later it becomes a larger mass, sometimes projecting into the vaginal vault and even covered with nodular papillomatous excrescences. Ulceration may occur in the vaginal fornix, giving the mass a still closer resemblance to malignant disease. When examined per rectum the lumen is found to be narrowed by hard, unyielding induration in its anterior wall, but the mucous membrane, contrary to expectation, is found smooth and not ulcerated, moving on the subjacent mass. The occlusion of the rectum may be so great as to cause actual obstruction. The chief difficulty in diagnosis of all forms of extra-uterine adenomyoma is to distinguish it from malignant disease. The density of the adhesions, the hardness and complete fixity impart the impression of carcinoma, and when this is also combined with ulceration of the posterior vaginal vault the diagnosis of malignancy is very probably made. In some cases the final diagnostic decision can only rest upon microscopical examination.

Treatment.—If symptoms call for treatment it must be operative. The nature of the operation and its extent must depend upon the density of the adhesions and the condition found. Operation is usually difficult, partly because of adhesions and also because of the possible existence of other adenomyomata, such as the tumour which fastens the uterus firmly to the rectal wall. Simple ovarian endometrioma should be removed completely, but if the earlier stages are met with it is perhaps permissible to carry out a cuneiform resection of the ovary including the whole of the endometriomatous invasion, especially if the condition is bilateral. Sampson regards ovarian conservatism as "a rather dangerous experiment," but this view was based on the theory that the ovarian endometrioma was the parent of any other pelvic adenomyomatous deposits that might be found. Adenomyoma of the uterus requires pan-hysterectomy, except possibly where the growth is represented merely by a small cornual nodule which can be excised (though never *enucleated*, as these tumours have no capsule).

The most difficult condition is the rectogenital tumour, owing to its deep situation and firm double adhesion to the uterus and rectum. Owing to a mistaken diagnosis of malignant disease, very extensive operations have been done involving excision of the uterus and rectum, but a knowledge of the pathology makes it clear that this is not necessary except where the rectal lumen has been narrowed to such an extent as to cause obstruction. In ordinary cases it is sufficient to perform pan-hysterectomy, removing as much of the tumour off the rectal wall as can be done without injuring it.

Conclusion.—It is now established that the so-called "chocolate cyst" of the ovary is a collection of old blood derived from menstruating ectopic endometrial tissue, and further, that adenomyoma in any situation also contains islets of misplaced endometrium buried in myomatous tissue. Many questions on the origin of these curious tumours arise,

but it is by no means certain that they have yet been correctly answered. The first difficulty that arises is why fragments of exfoliated endometrium should, in some women, at some time in their lives, have the capacity for erosion of the tissue on which they are deposited. Even the sustained life of such displaced fragments is difficult to understand apart from the added power of eroding a host-tissue. An example of the difficulty of this question is the case recently reported by Palmer (8) of an endometriomatous nodule developing on the vulva. Flakes of endometrium normally pass down the vagina and over the vulval mucosa every month without taking root therein, but here was a case in which adhesion and penetration of the mucous membrane took place.

The second difficulty requiring explanation is the presence of muscle fibres in the extra-uterine adenomyomata. This tissue is never found in the ovarian form of endometrioma, but in the pelvic peritoneum, ovarian ligament, round ligament, and rectogenital space, muscle fibres are a feature of the tumour. It is difficult to see how the growth of ectopic endometrium in these situations can also produce a myomatous formation. On the theory of Bailey the most difficult point of all to explain is how these tumours can occur in the extra-abdominal situations of the inguinal canal and even the labium majus and umbilicus. However, Bailey has produced histological evidence which fully accounts for the ovarian endometrioma, and, until further work is done to modify or refute his view, it seems right to accept it as rational.

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CHAPTER XII

THE USE OF X-RAYS IN OBSTETRICS AND GYNÆCOLOGY

By J. H. DOUGLAS WEBSTER, M.D., M.R.C.P.

Introductory

1. That X-ray examination might facilitate pelvic mensuration, early and differential diagnosis of pregnancy, and the diagnosis of abnormal pregnancy, was recognised by many of the earlier workers with X-rays, for in the five years following Roentgen's discovery in 1895 a number of papers appeared in different countries noting the first obstetrical applications of the new method of clinical exploration. Davis and Varnier in 1896 published observations, and by 1900 there was a considerable literature on the subject.

The recent introduction of the Potter-Bucky diaphragm has been a great assistance to X-ray diagnosis in obstetrical work. The technique of peritoneal gas inflation (pneumoperitoneum) has made possible, in addition, demonstration of the outlines of the uterus, tubes and ovaries *in situ*, and by this means in doubtful cases before a laparotomy, or when a laparotomy is inadvisable, gynæcological differential diagnosis may be assisted.

2. X-ray treatment also was soon given a trial in the early days of radiotherapy, but with little or no success for ten years, until advance had been made in apparatus construction and methods of X-ray measurement, and many biological experiments had shown the great sensitiveness of ovaries and testes to radiation in comparison with most other bodily

organs and tissues. The basis of modern deep ray therapy was laid down in great part in gynæcological clinics in the period of 1904–11, the first stage being the treatment of uterine fibroids, following which the more difficult problems involved in the treatment of uterine, ovarian and vulvar cancer have been widely studied. In general it may be said that gynæcological cancer is one of the most promising regions in which radiation treatment of malignant disease may be undertaken.

Part I.—Diagnosis

1. **Pelvic Mensuration.**—Owing to the obliquity of the plane of the pelvic inlet to the horizontal (56 degrees), the usual anatomical direct antero-posterior (or postero-anterior) projection gives a very imperfect view of the pelvic size and shape. Compare Figs. 24 and 25. A truer approximation to the actual bony outline and measurements can be obtained in a number of ways: (*a*) by stereoscopic views in various projections, or (*b*) by the comparison method of Fabre, or (*c*) by that of projection from varying distances on to a plate or film with the central ray perpendicular to the centre of the plane of the pelvic inlet.

(*a*) *The Stereoscopic Method*, based on the cross-thread device of Mackenzie Davidson, has been widely used either in simple form, or in the elaborations of Mazo, or the "measuring chair" of Kehrer and Dessauer and Martius. The chief objection to the simpler stereoscopic methods is the difficulty often found in defining the promontory in views oblique to the pelvic plane; this renders the longitudinal diameter frequently uncertain. The more accurate stereoscopic methods require special and expensive apparatus, and are, therefore, not suitable for general use.

(*b*) *The Comparison Method of Fabre.*—Four adjustable wooden or metal bars are used, the centimetres being marked off in lead. These are fixed in position around the patient's hips, parallel with the pelvic inlet, the patient being either

in the ventral or dorsal position. A radiograph is then taken with the central ray approximately perpendicular to the centre of the pelvic inlet plane, including the external rectangle of measuring bars. The tube focus (tube above the couch) is at 65 cm. distance from the horizontal, and is vertically over a point 20 cm. *above* the pubic symphysis when the patient is in a dorsal position, or 20 cm. *below* the pubic symphysis if the patient is lying prone. Fabre recommends the prone position, as this position shows the promontory more distinctly, and the rest of the sacrum is less evident. On the resulting negative, or on a tracing of it, the corresponding opposing centimetre marks are joined together, and the number of intersections marks off the longitudinal and transverse internal diameters in centimetres and parts of a centimetre. The pelvic inlet size and shape are well seen, as in Fig. 25. This method is complicated by the fact that the longitudinal and transverse pelvic diameters are not exactly in the same place, so the index rods in one rectangle cannot be truly parallel to both of them. (To obviate this objection Fabre suggested two rectangles, one parallel to the longitudinal, the other to the transverse plane.) Then the fifth lumbar spine varies considerably in antero-posterior diameter, so that the relative position of the posterior measuring bar is slightly uncertain compared with the promontory. Small errors therefore are liable to occur in measurement, but with the method carefully carried out the error should not exceed half a centimetre. A similar method without index rods, measuring the diameters by deduction from the negative of so much for the enlargement produced, is more open to error, owing to stoutness or lordosis causing varying obliquities of the pelvic inlet plane to the examining couch and film.

(*c*) *The Parallel Planes Method.*—In this method, adapted from cardiac orthodiagraphic methods, the screen or photographic plate or film is placed parallel with the plane of the true pelvic inlet (fifth dorsal spine and upper level of the pubic

symphysis). With the tube above the couch, the patient can either lie on the back or sit semi-recumbent, the film being placed at the perineum ; or else the patient can lie prone, in a modified knee-elbow position, the film being between the umbilicus and symphysis. The latter position is only convenient in thin patients and in early pregnancy. The greater the distance of the tube the less will be the magnification on the film. A distance of 2 metres is commonly chosen, and the magnification for a normal pelvic longitudinal diameter of 11 cm., situated 8 cm. from the film, will be 4 to 5 mm. The patient, film and X-ray tube must be oriented carefully before the radiograph is taken by fixing the position of bony points, and the central ray from the tube must be perpendicular to the centre of the parallel planes of the pelvic inlet and the photographic film. Experiments with an anatomical pelvis are advisable before attempting clinically methods of pelvic mensuration, also to check the readings found with patients by different methods. Possible errors with Method (*c*) should not exceed 3 mm. in any diameter.

This parallel planes method may be employed for radioscopic measurements, as in cardiac orthodiagraphy, the fluorescent screen being placed parallel with the pelvic inlet, the tube being below the patient, who is semi-recumbent or in a modified knee-elbow position. With a small diaphragm opening points may be marked on the screen, which when connected together give the diameters immediately. This is the quickest method possible, and may suffice in cases of urgency, or when the patient cannot keep still, or when the apparatus is not powerful enough, or is not arranged so as to give an exposure from a distance of 2 metres.

In all radiographic exposures of the pelvic bones sharp pictures are essential, giving the maximum contrast between the bones and the soft parts. Powerful apparatus and rapid exposures give the best results ; but if immobility of the patient can be ensured, apparatus of medium power can

give accurate results with the use of double intensifying screens and films, especially when combined with the use of the Potter-Bucky diaphragm.

2. **Diagnosis of Pregnancy.**—Ossification in the fœtus of the cranial bones, vertebral bodies, ribs, pelvis and long bones, is usually sufficiently far advanced for pregnancy to be demonstrated in the fourth month. Difficulty in X-ray diagnosis may occur from delayed ossification, much liquor amnii, complication with uterine or ovarian tumours, active fœtal movements, excessive stoutness or nervousness on the part of the patient, or deficiencies in the apparatus or technique. Maternal and fœtal immobility during exposure is a *sine quâ non* and is not always obtainable. By films inserted in the vagina Rodès demonstrated pregnancy at the third month, but this method is not likely to be available in those cases in which it would be of most help.

Pneumo-peritoneal technique has been employed by Peterson, who by this means has demonstrated significant enlargement of the uterus by the sixth or eighth week.

The patient may be in the dorsal, ventral or lateral position. In the first half of pregnancy, with the tube above the couch, the best position is probably the prone one in thin patients. The bladder should be empty, and intestinal emptying be ensured by mild laxatives; inflation of the rectum with air may help to show up finer details in the earliest months. In the middle months of pregnancy the patient can be either prone or supine; in the later months the dorsal position is more comfortable for the patient, and her immobility is more easily ensured by lying on the back than on the abdomen. In the middle and later months a lateral position is often useful, especially in very stout patients.

The presentation (vertex, brow, face, shoulder, breech or transverse) can be easily diagnosed, and the results of manipulation checked. In vertex presentations any gross disproportion between the fœtal head and the pelvic inlet

may be made out without proceeding to detailed methods of pelvic or cranial measurement. In breech presentations extension of a leg or legs can be readily shown if present. (See Figs. 24—27.)

Multiple conception is easily recognised in the second half of pregnancy; but the patients near full-term may be so large, or have such relaxed abdominal walls, that only one fœtus may be shown clearly in an antero-posterior view on a film of 10 in. × 12 in. size; though a lateral view will show the twins with certainty. This was so with the patient in Fig. 28. (Mr. Comyns Berkeley kindly agreed to this publication of Figs. 24—28 from patients under his care.) Fœtal abnormalities, such as hydrocephalus, anencephaly or lithopædion, can be demonstrated, and the diagnosis of a mole pregnancy may be helped by the absence of fœtal shadows.

Extra-uterine pregnancy may be differentiated from ovarian or tubal growths by X-ray methods alone; extra-uterine pregnancy can only be differentiated from uterine pregnancy by a pneumoperitoneal technique, for a tubal pregnancy may have a medial position in the pelvis and abdomen.

With the use of highly sensitive films, double intensifying screens, and the Potter-Bucky diaphragm, exposures of two to twenty seconds should be sufficient, even in the later months of pregnancy. As many thousand examinations have taken place without fœtal damage being recorded, the procedure as usually conducted may be considered to be entirely lacking in danger to the fœtus.

3. **Mechanism and Complications of Labour.**—Several detailed X-ray studies of the mechanism of labour have been carried out in recent years, and Warnekros has an atlas of labour mechanism and complications which should be referred to by those specially interested in this branch of the work.

4. **Gynæcological Diagnosis.**—With a pneumo-peritoneal technique Peterson (1) has reported 325 cases, nearly half of

Fig. 24.—Vertex presentation: 8th month.

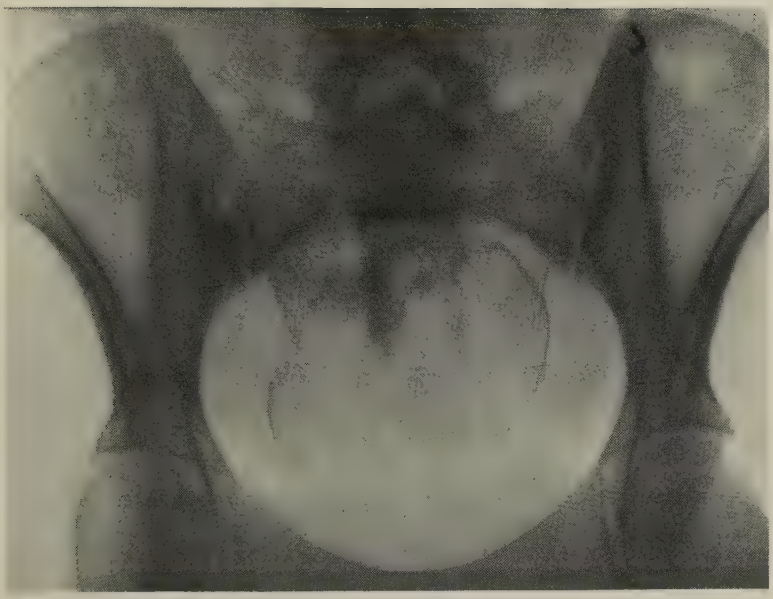

FIG. 25.—6th month: Oblique view: from 20 cm. above symphysis; 65 cm. from horizontal. (Method (*b*) without index rods.)

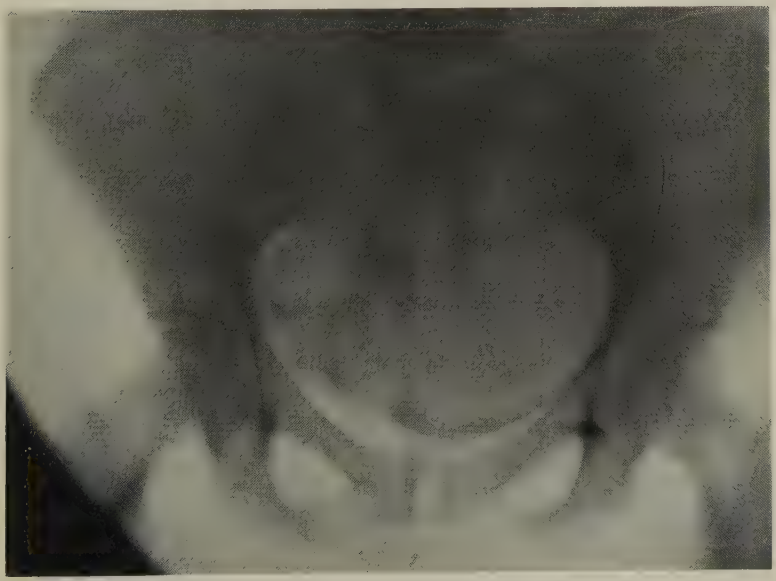

FIG. 26.—Brow presentation (patient in labour).

Fig. 27.—Breech presentation : with extended legs.

FIG. 28.—Twin pregnancy: 8th month: breech presentation. Lateral view (one face looks upwards, the other down).

which were explored afterwards. In some cases of early ovarian tumour, hydatid cysts, pelvic inflammation or tubal pregnancy this has assisted diagnosis before laparotomy, or has been a substitute for laparotomy. Its use is, however, at present still largely in an experimental stage,

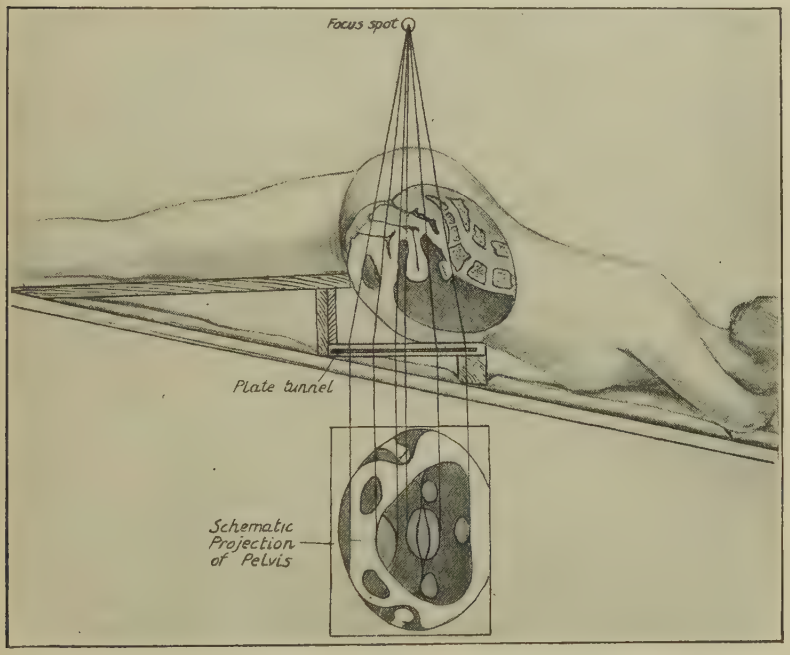

Fig. 29.—Peritoneal gas inflation. Schematic (after Peterson).

and it is therefore not here referred to in detail. (See Fig. 29.)

The injection of air or gas into the abdomen through the uterus and Fallopian tube with X-ray control has been lately practised by several workers as a means of testing the patency of the Fallopian tubes, especially in the investigation of the causes of sterility. The lumen and position of the tubes can also be demonstrated by injection of non-irri-

tating opaque fluids, radiographic (preferably stereoscopic) exposures following.

Part II.—Therapy

Radiation therapy has in gynæcological disease one of its most active and useful fields, both for biological and technical reasons. Only lymphatic tissue is more radiosensitive than the ovaries, ovarian carcinoma is often highly radiosensitive, and cervical carcinoma in a large percentage of cases is a radiosensitive squamous-celled growth. Further, the site of the uterus—centrally placed in the body, and therefore ideal for "cross-fire"—and its quiescence, makes cancer there compare favourably for radiation treatment with malignant disease in other sites of the body, especially with gastro-intestinal cancer. The physical and instrumental bases of radiotherapy cannot here be discussed, and the biological bases will only be referred to very briefly.

Gynæcological X-ray therapy had its first considerable success about 1904–6 in the treatment of uterine fibroids and excessive hæmorrhage near the climacteric in the hands of Albers-Schönberg, Halberstädter, Beaujardin and others. Clinical work was confirmed by animal experiments, in which the arrest of ovulation and menstruation, following X-ray doses insufficient to cause skin changes, was consistently found in several series of radiations on small animals—rabbits, mice, etc. Some weeks after exposure the radiated ovaries were found to have shrunk in size compared with the non-radiated ovaries in the same animal or with normal controls. The Graafian follicles ceased to ripen, and on section they showed degenerative changes, vacuolation and alterations in staining, etc. By varying the intensity of the dose applied all degrees of change were produced, varying from simple arrest of ovulation with little or no vascular or interstitial cellular change to profound atrophy of the whole gland.

This first branch of gynæcological therapy is one therefore

where diminished reproductive function is aimed at, thereby antedating the normal menopause : in successful cases, if there are excessive hæmorrhages they cease, if there are fibroids they shrink or disappear.

The second chief branch of therapy is concerned with gynæcological malignant disease. Here the aim in advanced cases is at least at the arrest of the reproductive invading power of malignant cells, while in favourable cases so much direct and indirect damage to malignant cells may result that they cease to be viable, and their degenerated residue is removed by local cellular reaction, and ultimately replaced by normal scar tissue.

This second branch of therapy is more complicated than the first, owing to the radiosensitiveness of malignant cells in general being less than that of the ovaries, also owing to the varying radiosensitiveness of different types of malignant cells and the varying response of different patients to radiation. Then the sites involved may be strictly local, or there may be wide areas of invasion. Further, there are the technical difficulties in radiating areas lying at varying depths from the skin surface, with X-ray intensities sufficient to induce the damage necessary, together with minimal change to normal structures ; much practice is therefore necessary before successful results can be attained, in addition to a long clinical, pathological and radiological training.

Other divisions of therapy, such as treatment of tuberculous and inflammatory adnexæ and stimulation endocrine therapy, will be mentioned later.

1. **Artificial Menopause.**—The indications and contra-indications for radiotherapeutic production of an artificial menopause will be discussed in detail, and contrasted with myomectomy, hysterectomy or oöphorectomy by Mr. Aleck Bourne in another place. It is a valuable treatment in osteomalacia, and has been tried in exophthalmic goitre, tuberculosis of the lungs, and cancer. In gynæcological conditions it will be obvious that uncertainty of diagnosis as

to possible malignant degeneration in fibroids, or the possibility of inflammatory adnexa or of ovarian tumour, or the presence of pedunculated submucous fibroids, may render operation essential for diagnosis or treatment. Indications and contra-indications for radiation treatment of fibroids have been much discussed in recent years. The opinions of those who consider perhaps 10% suitable for radiation treatment may be contrasted with others agreeing with A. Béclère (2) (on a basis of over 1,000 cases), that only such patients as urgently demand surgical interference are unsuitable for X-ray treatment. Whatever view be taken up, X-ray treatment can, however, no longer be considered experimental, and those who wish full details should consult Schmid's article (3) analysing 5,219 cases (up to 1920), followed up in 5,053 cases with a clinical cure in 96·2%, several large clinics reporting 99 to 100% of cures with X-ray treatment in uterine fibroids and excessive hæmorrhage near the menopause. The advantages of X-ray treatment are: (1) There is no mortality; (2) the treatment can be given in almost all cases in one to three hours on one day without local or constitutional effects, therefore causing no interference with employment or avocation; (3) the risk of lighting up old inflammatory trouble is much less than with radium intrauterine applications.

The earlier technique was developed about 1904, and was to give empirically repeated series of three or four abdominal applications at monthly intervals till the monthly or intermenstrual flow ceased. With the apparatus then in general use, giving from 4 to 10% of the skin dose at 10 cm. depth, many months' treatment was required. Attempts were then made by multiplying the number of abdominal fields to increase the dose received by the ovaries, each dose being concentrated on one or other ovary, or being directed on to the fibroid tumour. These techniques involved, with 3 mm. aluminium filter, as many as 14 to 36 or even 46 fields (8 to 30 abdominal and 6 to 16 dorsal), 3 to 4 series being

given with three-weekly doses, and amenorrhœa resulting on the average in three to four months.

This prolonged treatment with low voltage apparatus has now been superseded in most clinics by a high voltage technique, whereby the dose at 10 cm. depth may be 20 to 30% of the surface dose, and the whole treatment may be given in a single calculated dose in two to three hours on one day, or in one to three days, no skin erythema dose being given on any one area in thin patients, and no general reaction resulting, the patients being able to travel home the same day, even if this involves several hours' train journey. Repetition of this single dose should now only be necessary in the rarest cases, and after several months, as, for example, if the ovaries' position is uncertain, and the dose calculated has not been received.

By ionisation measurements with ionisation chamber in the vagina or rectum, and comparative measurements on water or wax phantoms, the minimal dose at each ovary necessary to cause amenorrhœa has been estimated to be 34% of the minimal skin erythema dose, that is to say, 34% of a dose which causes slight skin redness in a week and slight brown colouration in three weeks, the latter persisting for about six weeks, and then fading away gradually.

By the simplest technique with high voltage apparatus the necessary dose can be given to each ovary with one anterior and one posterior field of 8 × 8 cm.* On each area 50% or more of the skin dose will be necessary according to the antero-posterior diameter of each individual patient. The time necessary for treatment may be shortened by giving two small anterior (or one large anterior) and one large posterior field, two or three fields in all, the total time necessary being three-quarters of an hour to two and a half hours. In unusually stout patients the depth dose must be increased by multiplication of fields. Doses at the ovary slightly less than 34% may produce only a temporary amenorrhœa,

* See Figs. 30 and 31.

ovulation occurring again in some uninfluenced follicles after an interval of a few months to one to three years. This smaller dose, which requires great technical accuracy, may be given deliberately to younger nubile patients, or one ovary only may be treated. Such treatment may produce marked improvement (acting as a partial thyroidectomy or X-ray treatment does in exophthalmic goitre patients), and younger patients suffering from excessive menstruation may be treated with benefit by this method.

Wintz, who has induced an artificial menopause in nearly

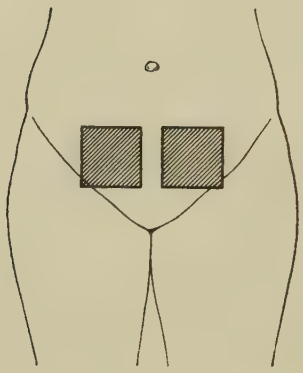

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FIG. 30.—Artificial menopause. 2 anterior fields (8 × 8 cm.).

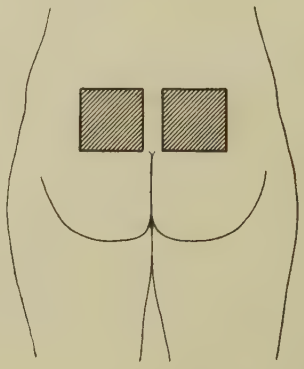

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FIG. 31.—Artificial menopause. 2 posterior fields (8 × 8 cm.).

1,000 patients, has concluded that the sooner after the cessation of a menstrual period the dose is administered the more likely it is that there will be no further flow. If the dose be given in the second half of the intermenstruum, or doses at any time be divided over several days, or if minimal doses be given, or there be uncertainty as to the position of one or both ovaries, then one or two more periods may occur before cessation. By giving minimal doses in several cases I have found one or more periods occur (never more in quantity, usually less, than before); then without any further treatment

amenorrhœa ensued. A series of patients has been treated with uniform success both by the divided dose and the single dose methods. Of the last eight cases treated in one day, none has suffered from nausea, sickness or general or local disturbance; and in their treatment, such patients are given much less radiation than is required for malignant disease. In each of these cases amenorrhœa has followed in three weeks to three months with minimal symptoms due to the menopause. The appearance, weight and blood condition improve rapidly, and nervous and other symptoms of the menopause are usually very slight, because the ovarian internal secretion is not wholly or abruptly abolished, as it is after oöphorectomy. Some have found that younger patients require larger doses to produce permanent amenorrhœa, but this is denied by Wintz and several other gynæcologists. As to the action of the radiation on the myoma, apparently that is chiefly indirect, through influence on ovarian function, and is not a direct action on the tumour itself. More research, however, is necessary before this point can be finally determined. If Schmid's article, already referred to, be consulted, it will be noted that the best general and local results come from techniques which use fields concentrated on the anatomically localised ovaries, with exact measurement of the ovarian dosage, not from those techniques which give empirical treatment with large or very many abdominal and pelvic fields, and with little or no attempt to measure the ovarian dose for each patient as determined by the apparatus used, and by each patient's measurements.

2. **Carcinoma of the Cervix.**—As about 25% of patients with cervix cancer come under observation with the disease already advanced to an inoperable stage, there is here a large field open for radiation therapy. For most operable cases in England, operation is the only means of treatment readily available; but in five or six large gynæcological clinics abroad for eight or so years operation has been

entirely abandoned, in all cases, for some form of radiation treatment. Some workers have reported that they have found their operable *plus* inoperable cases treated by radiation show better end results than the average cure they have found after Wertheim's operation. It was Krönig, dissatisfied with the immediate and end results of operation, who initiated the modern radiation treatment of gynæcological cancer. The opinion of the majority of gynæcologists would still appear to be, however, that operable cancer of the cervix should be operated upon in the absence of special contra-indications. Mr. Aleck Bourne discusses clinically and pathologically cancer of the cervix elsewhere, and its operative aspects, and the indications for and against operation and radiation, and Mr. Malcolm Donaldson discusses elsewhere the indications for and against operation and radium treatment, and gives his technique and results in recent years with radium treatment. From the X-ray clinical point of view cervix carcinoma may be divided into :—

A. Primary. i. Operable.
ii. Borderline.
iii. Inoperable.

B. Combination of Radiation with Operation.
i. Pre-operative and
ii. Post-operative or "prophylactic" radiation, or radiation after incomplete operations.

C. Treatment of Recurrent Cases, usually Inoperable.

D. Combination of X-ray with Radium Treatment.

From the X-ray technical point of view the radiation may be given by (*a*) large fields ; (*b*) multiple small fields ; (*c*) combination of large and small fields.

A. Primary.—(i.) Operable (as the method of choice, or when operation is refused or is inadvisable). In this group there is an area of perhaps $4 \times 5 \times 6$ cm. of malignant

cervix freely mobile, with no evidence of parametrium infiltration. Each parametrium should however be treated as if early invasion had already taken place there. Various techniques have been evolved, and are still being evolved, to irradiate the cervix and pelvic lines of spread.

(*a*) *Large Fields.*—In one large field method the whole pelvis is irradiated by cross-fire from anterior, posterior and both lateral aspects, each dose and the resulting depth dose at different levels being calculated by vaginal or rectal ionisation methods, or by comparison measurements on wax or water phantoms. Variations on this are three fields at 120°,* and Holfelder's tetrahedral method. Surface dosage in each area varies with the patient's thickness. The anterior skin can be safely given more treatment than the posterior skin, especially in thin or debilitated patients who may be confined to bed. With full posterior doses such patients may show signs of skin damage from pressure on the irradiated parts. In stout patients by the first method almost a blistering anterior dose is necessary if a sufficient depth dose is to be given; therefore in very stout patients (20 cm. or over) a fifth field, perineal or oblique posterior, must be given, or X-rays be combined with radium to the cervix. Such large field methods are now usually employed in prophylactic work, and are suitable for some inoperable and recurrent cases. Of operable cervix cases treated by the four-field method (anterior, posterior, two lateral) Bumm reported cures in all of five patients.

(*b*) *Small Fields.*—The small or concentration field method in operable and other cervix cancer has been described in detail by Seitz and Wintz in their "Roentgen-Wertheim" technique. By this method six fields, 6 × 8 cm. each, three anterior and three posterior, are first precisely concentrated on the accurately localised cervix, and according to the thickness of the patient a surface dose on each area is given so that the summation of the six doses at the cervix

* See Fig. 32.

will give there 110 to 120% of the minimal skin erythema dose. In stout patients one or two additional fields, vulvar and perineal, are necessary. After a six weeks' interval, during which the skin and the patient's blood recover, the right parametrium is similarly irradiated with six concentra-

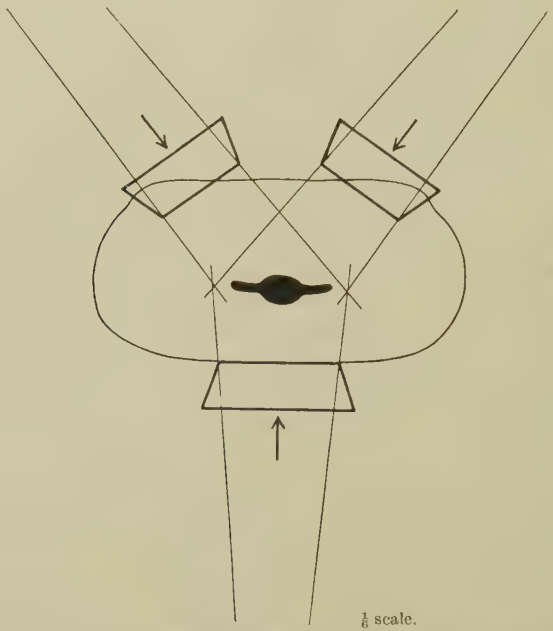

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FIG. 32.—Three fields at approximately 120°. Schematic: suitable for thin patient; high-voltage; tube at 50–60 cm. D. Lateral or perineal fields could be added for stouter patients.

tion fields (unless the left is evidently involved, when it is treated before the right). After a further six weeks' pause the left parametrium has similarly six fields concentrated on it.* With this method, for further details of which his writings with Seitz should be consulted, Wintz (4) has reported a five years' cure of 66% of operable and 12% of inoperable

* See Fig. 33.

cases treated. Treatment of the whole area at one time had not as good a result, Wintz found, as this divided technique. Concentration small field methods are also suitable for recurrences after hysterectomy. Without the greatest precision in anatomical orientation of these small fields there is risk in underdosing and overdosing some areas, as Fig. 34 shows.

(*c*) *Combined Large and Small Fields.*—Combined technique with large and small fields may be worked out. This will be considered later under inoperable cases.

A. ii. and iii.—Borderline and inoperable cases should be considered together. They vary considerably in degree of severity. Cases not operated upon, with slight fixation, where one parametrium shows enlargement due to chronic inflammation or possible malignant invasion, or when the upper vagina is slightly involved, should be treated as suggested below for inoperable cases. Slight inoperable recurrences at the upper part of the vagina after Wertheim's operations may well be treated by the concentration small field method, especially if the recurrence comes on a good many years after operation. With signs of recurrence soon after operation a large field method is probably better.

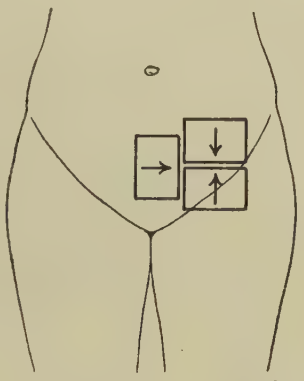

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FIG. 33.—Method (*b*): concentration small fields (6 × 8 cm.). Anterior: L. parametrium, or small recurrence in L. Fornix. Posterior fields similar.

In very advanced primary cases with invasion of the bladder or rectum, or cachexia, or ascites and secondary deposits in the abdomen or liver, great care should be taken not to over-treat, as there is practically no possibility of cure, and harm may be done by giving massive radiations through-

out the whole pelvis and abdomen. An attempt should first be made to relieve pain, hæmorrhage or discharge, and to prevent further extension of the disease. Combined radium

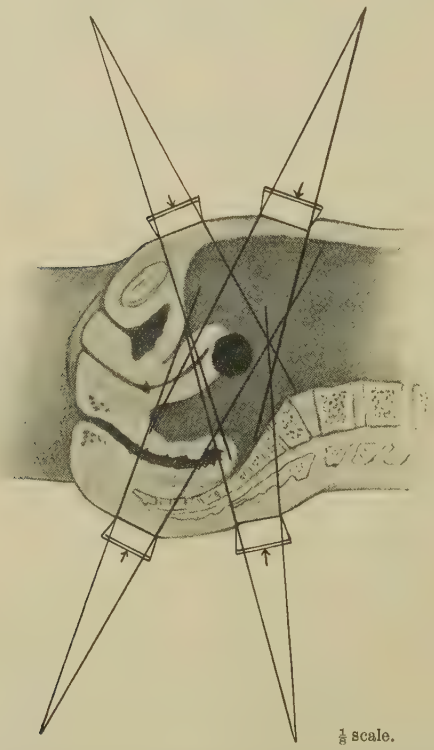

FIG. 34.—Mesial section (schematic): very stout patient. Method (*b*): concentration very small fields (5 × 7 cm.): 23 cm. D. For small ovarian primary or recurrence: the opposite side should be similarly treated with 4 fields. Illustrates but exaggerates the difficulty of accurate projection: large field methods are simpler in practice.

and X-ray treatment is frequently advisable in such advanced cases, and in a considerable percentage temporary improvement is marked, and may last for from six months to three years. In such advanced cases the growth usually becomes

more movable, and there may be complete freedom from hæmorrhage and discharge ; pain is frequently relieved ; and swelling of the legs due to iliac gland pressure may completely disappear.

The techniques of the large fields and multiple small fields have been given or referred to already. Another technique for moderately advanced inoperable cervix cases is that of a combined large and small field method. One 10 × 15 applicator may be used with the long axis transversely at and above the symphysis, centred on the broadened cervix, with or without a 3 cm. wax block between the applicator and the skin. The wax may be used with stout patients ; with thin patients it will not be needed. Two to four or more supplementary 6 × 8 fields may be given anteriorly round this area to increase the lateral intensity of the large field, or concentrated on one or both obdurators, for the intensity is always less at the margins of a radiation field. Posteriorly four to six fields may be used, 6 × 8 cm. in size, or a similar large 10 × 15 applicator with supplementary concentration fields, less surface dose always being given posteriorly than anteriorly. Additional vulvar or perineal doses may be given.

Before treating each patient measurements should be made, (1) of the palpable and probable extent of the growth, (2) of the patient's various diameters with and without abdominal compression. The blood should also be fully examined. Then, with tables of depth intensities for the particular apparatus and tube used, and diagrams to scale, and Holfelder's or other sections of the body in different planes, a technique should be devised which will give approximately a homogeneous intensity of radiation throughout the area of the tumour and the neighbouring lymphatics. In most cases there is a large septic factor. This may be lessened, and the growth rendered more radiosensitive, by a preliminary ionisation of the cervix with copper or zinc, or by local diathermy applications. The whole of the X-ray treatment

series should be given within a week or ten days. Careful preparation of the patient is necessary before each application, thus no metallic drugs should be taken by mouth, and the intestines should be well cleared by laxatives or enemata. Solid food but not fluid should be withheld for at least two hours previously. Those liable to radiation sickness should have, beforehand, bicarbonate, salt, calcium lactate, chloretone, alcohol, atropine, or a scopolamine-omnopon injection. Suitable division of the dose, however, is the best preventive of sickness, together with free ventilation. During any long treatment the bladder should be emptied frequently. Repetition of such a treatment series may take place in six or eight weeks, and again in three or four months; thereafter it may be given again in six or eight months if sufficient regression of the disease has not taken place, or if there are signs of renewed growth or invasion. At Erlangen one effective irradiation is the aim, no further treatment by X-rays being given unless there are signs of renewed growth. What is usually found is that there is marked improvement after the first or second treatment; the cervix is smaller and more mobile, the parametrium less thickened; there is lessening or absence of pain and sense of weight; the hæmorrhage or discharge is much less, or has ceased; the patient has put on weight rapidly, and looks and feels in very much better health. As adjuvants to the treatment injections of iron, arsenic, copper or iodine, may be given, or ultra-violet light or Alpine "cures." Even advanced inoperable cases may improve for many months or several years, while some have been reported as apparently cured after three or five or more years.

B. Treatment with Operation, Pre-operative and Post-operative.—Of these post-operative treatment has been most generally employed. Of a large series reported by Warnekros, in 190 patients the percentage of recurrences in patients who had no post-operative radiation was twice that shown by similar patients who had post-operative radia-

tion (72 to 36% after five years). Winter has reported similar results. The writer is now carrying through a series of treatments with post-operative radiation after Wertheim's operation by Mr. Comyns Berkeley, but sufficient time has not yet elapsed for the results to be apparent (in 41 cases up to the present). The technique followed is that of irradiating the whole pelvis from four large fields, one anteriorly and one posteriorly and two laterally, the anterior and posterior fields being about 16 × 22 cm. and the lateral fields being about 10 × 15. Pre-operative treatment with a similar technique has been used in some clinics, but not to any large extent. Its employment, however, would seem to be indicated, as many workers have reported marked regressive changes after pre-operative radiation of operable mammary and uterine cancer. And it is recommended because after its use (1) post-operative peritonitis is lessened over 50% in septic cases (10—4·4%), (2) inoperable cases have been made operable, and (3) there is less risk of dissemination and recurrence (Meyer (5)).

After post-operative radiation Siegel recommends monthly examinations of the patient to detect any signs of recurrence as soon as possible. At least three-monthly examinations should be made. The outlook for the patient is much more favourable if further radiation be given to very early recurrences than if they are treated when they have reported with symptoms due to masses 3—10 cms. or more in size, as too frequently happens.

C. Combination with Radium Treatment.—Apart from the difficulty of calculating the total radiation in combined radium and X-ray treatment, this technique appears a suitable one, especially for very stout patients. The writer has treated a number of inoperable cases after radium has been inserted into the cervix, a period of three weeks usually being allowed to elapse between the radium and the X-ray treatment. Combined treatment has been abandoned by a number of workers who used it originally, because of the diffi-

culty of calculating the total dosage and the risk of over-dosage in certain areas, with the production of damage to the bladder, or rectum, or bowel, and possible causing of fistula. This combined method however will probably have a definite field of usefulness.

3. Carcinoma of the Body of the Uterus.—This may be treated when the uterus is small, as in technique 5 (*b*), with small concentration fields, the central axis of the radiation being higher up than for cervix cases. Where the patient comes under observation with a large tumour, treatment may be as in 5 (*a*), with large fields, or 5 (*c*) several combined large or small fields. Primary cases are usually operated on owing to the difficulty of establishing diagnosis. Post-operative radiation treatment would appear to be indicated, especially of the aortic gland area, though I am not aware of many observations on this subject.

4. Sarcoma of the Uterus.—Where treatment is undertaken for what is apparently a uterine fibroid of small size by the four small field method (two anterior and two posterior, concentrated on the ovaries), the combined cross-fire from the four areas gives in the uterus a dose equal to about 70%, which is sufficient to cause rapid regression in size in most uterine sarcomata. Rapid lessening in size of a small uterine " fibroid " may lead therefore to the suspicion that it was a sarcoma. After treatment for a small " fibroid," should a rapid increase in size take place after " castration " treatment, this should suggest that sarcomatous change is present, and further radiation should be given promptly to the uterus, or operation be performed. Seitz and Wintz have reported several cases in which further radiation was given with successful result. X-ray treatment in this way is of diagnostic value in uterine sarcoma.

5. Ovarian Neoplasms.—In ovarian tumours operation, if possible, is always advisable to find out the type of growth and the extent of invasion, if any. There is also a possibility that the ovarian tumour may be secondary to latent malig-

nant disease in the upper abdomen. Radiation treatment, as in cervix cancer, may be concerned with (i.) operable tumours where operation is refused, or is inadvisable ; (ii.) inoperable tumours ; (iii.) recurrent cases ; and (iv.) post-operative radiations. As if the one ovary is the site of growth the other may be, or may become, involved, it is probably better in most cases to treat both sides ; that is to say, radiation of the whole pelvis is the best technique.

(*a*) A large field technique appears to be the most suitable for post-operative treatment, or recurrence, or advanced inoperable cases. (See above, under Carcinoma of the Cervix.)

(*b*) The small concentration field method may be used for small recurrences or small inoperable cases ; four anterior and four posterior 6 × 8 fields may be used. This method requires great care in giving it, as the medial summation of eight fields, each with the full skin dose, might give 160% or more in one area in a thin patient, which would not matter if this place were occupied by the body of the uterus, but it might be followed by hæmorrhagic diarrhœa a week or so after treatment, or by late ulceration,—of the small bowel (if fixed by adhesions near the middle line of the pelvis) or of the anterior rectal wall. To avoid this, especially in thin patients, all the fields should not be projected towards the medial sagittal plane, but four fields should have their central rays divergent, each lateral two fields converging, as in the usual technique, from above downwards and below upwards. Various techniques can be worked out on life-sized models with biological test objects such as sprouting beans or peas, or on water or wax phantoms, to ensure a close approximation to a homogeneous dosage throughout the pelvis. With this small field concentration method only the true pelvis can be uniformly radiated ; if abdominal implantations must be included, then, as an alternative or addition, a large field method should be used. Seitz says that by the small concentration field method a primary ovarian

growth of no size larger than a small orange can be successfully radiated ; the writer by this technique has seen reduction in size after one treatment, and disappearance after a second series, of small ovarian metastases in the pelvis, and on the anterior rectal wall.

(*c*) Combined methods of large and small fields with large inoperable ovarian tumours filling up the pelvis, or spreading up into the abdomen medially or laterally, may be suitable for use in individual cases.

As many ovarian tumours are markedly radiosensitive (similar in this way to testicular growths), most striking disappearances of large growths and widely scattered recurrences have been seen : a good prognosis may be given as regards the temporary result, at least, in a number of apparently hopeless ovarian cases. The writer has under observation a patient with a recurrent mass invading most of the anterior abdominal wall, which has become about a quarter of the original size, and appears to be in a quiescent state, the patient remaining in a good general condition. The original tumour and one large recurrence had been operated on by Mr. Victor Bonney. In thin patients one cannot push treatment of such large surface recurrences without risk of causing damage to the intestines or the blood.

6. Carcinoma of the Vagina.—This is usually an extension of cervical carcinoma, or a recurrence after a hysterectomy in which much of the vagina has been left at the operation. If the recurrence is small and high up in one or other fornix, treatment should be very similar to that for primary operable cancer of the cervix, with small concentration fields, say six in all, three anterior and three posterior, or three fields at 120°, or a tetrahedral method. The writer has had three or four cases lately treated with great delay in the progress of the disease. In one of these cases the treatment has been combined with vaginal radium applications. Additional vulvar or perineal doses must be given to stout patients, or

vaginal applications of radium, or X-rays through a glass speculum. The results in vaginal cancer are much less satisfactory as a whole than they are in cervical, probably because there is less local tissue surrounding the growth, and this local tissue reaction is apparently one of the essential factors in cure after radiation.

7. Diseases of the Vulva.—(*a*) Pruritus and (*b*) kraurosis are sometimes relieved by a few X-ray applications when other measures have failed. (*c*) Pre-cancerous leukoplakia. This may be treated by X-rays with improvement, two or three maximal doses being given at a four to eight weeks interval. The patient should be kept closely under observation, and operation or a change to radium treatment should not be delayed if there should be any change for the worse.

(*d*) CARCINOMA. This is usually an infiltrative type of epithelioma ranging in size from 2 to 5 cm. in diameter, with a depth of from $\frac{1}{2}$ to 3 or more centimetres. If protuberant it may be possible to cross-fire the growth and its base from a near distance, from above in front, from below and behind, and laterally, with tubular applicators, but when flat or ulcerative, and cross-fire is impossible, if operation be not undertaken, radiation treatment must either be with distance radium or radio-puncture, or with X-rays (*a*) from a great distance or (*b*) from a medium distance with plastic wax or other superficial application, both these methods aiming at an efficient dose in the depth of the growth.

By near techniques with rays not sufficiently penetrating, treatment some years ago, as a rule, entirely failed to prevent extension of the growth in its deeper layers.

Seitz and Wintz made a notable advance in X-ray technique when they treated vulvar cancer by radiation from a tube at a metre distance, the very marked improvement in their results over the old near X-ray technique showing that technical factors such as the dose received by the deeper layers of the growth are of vital importance. They use a 9 × 12 cm. vulvar field from a metre distance, and in all

cases treat the inguinal glands on each side at a distance of say 40 cm., repeating this inguinal dose in six to eight weeks, and again in three months, if advisable, as one dose from 40 cm. does not give a sufficient depth dose to malignant inguinal glands when treated only from one aspect and not cross-fired. Care has to be taken that there is no overlapping of the vulvar and inguinal fields.

(*e*) SARCOMA.—The writer has given post-operative radiation to a patient who had had a sarcoma of Bartholini's gland removed, together with the inguinal glands on both sides. Speedy generalisation of the disease, however, became evident. Pre-operative radiation might help in such cases, and treatment of sarcomata by radiation only has several strong advocates.

8. Fallopian Tubes.—Radiation treatment of tuberculous and chronic inflammatory tubes has been carried out in several Continental clinics. Tuberculous salpingitis, often associated with tuberculous peritonitis, has responded particularly well to doses about half the skin dose throughout the affected area, with three or four concentration fields anteriorly and posteriorly in salpingitis, and with large anterior and posterior fields in abdominal tuberculosis. Chronic inflammatory tubal conditions have lately been found also to respond well to moderate radiation.

9. Ovarian Stimulation Therapy.—There is already a large literature on this in connection with Viennese rejuvenation theories. Many cases of amenorrhœa in young persons have been speedily cured with small ovarian X-ray doses, and this may prove to be a useful advance in radiation therapy (Recasens (6)).

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CHAPTER XIII

ELECTROTHERAPEUTICS IN GYNÆCOLOGY

By JUSTINA WILSON, M.R.C.P. (Ed.), D.M.R.E. (Camb.)

In no branch of Electrotherapy has more progress been made during recent years than in that of diathermy, especially in its application to the cure of gonococcal infection of the uro-genital tract. In no other branch has patient research been crowned with such brilliant success. Nowhere else has such striking advance been made in technique.

These remarkable results are due to the work of two pioneers, Dr. E. P. Cumberbatch, Head of the Electro-therapeutic Department of St. Bartholomew's Hospital, and the chief exponent in this country of diathermy, and Dr. C. A. Robinson, his assistant.

These men have overcome great difficulties in the application of these complex high-frequency currents to the interior of the body, and they have devised practical and simple apparatus for their application. Thanks to them, English workers have now a safe and excellent technique to guide them and are well ahead of those of other countries in this particular line. There is, indeed, every reason why this new treatment should be successful. In the treatment of gynæcological disorders heat has always been recognised as a therapeutic agent of great importance. It has also been long known that the gonococcus is destroyed by a comparatively small rise of temperature, not high enough to damage living tissues. Years before Nagelschmidt produced the first diathermy machine, attempts were made to destroy the gonococcus by the introduction of heated sounds into urethra and cervix by douches, fomentations, and many forms of radiant heat. But all these methods failed because heat

transmitted by radiation or convection can never do more than induce superficial heat or epithermy. The gonococcus lurks in the deeper tissues, and to destroy it we need some agent that will penetrate to their depths. The only current which does this is diathermy. This heats all the tissues, superficial and deep, through which it passes, and thanks to this recent research we now know that, wherever it is, the gonococcus is destroyed by a ten minutes' exposure to a temperature raised 10 to 13° F. above normal.

The Diathermy Current

Diathermy currents are the outcome of the charging and discharging of condensers in a specially constructed circuit. The current accompanying the discharge will oscillate with high frequency if two conditions are fulfilled in the circuit. Firstly, it must have a low resistance; secondly, it must allow of a considerable amount of self-induction. These conditions are fulfilled if the condenser discharges through a solenoid or spiral of thick copper wire. The current thus generated oscillates through the circuit which is furnished with a suitable interrupter and spark gap, with a frequency of from 400,000 to two millions per second. Thus the rapidity of its oscillations is so great that all ionic movement is abolished. There are no electrolytic changes in the tissues, no muscular or sensory stimulus is possible, only a sedative effect is produced and heat that is not epithermy but diathermy, deep, penetrating, actually produced in the tissues themselves.

Methods of applying Diathermy to the Pelvis

The application of diathermy currents to the pelvic organs can be done in four different ways:—

1. Externally.
2. By the vaginal route.
3. By the rectal route.
4. Directly to the urethra and cervix.

1. **The External Method.**—Here one electrode is placed just above the symphysis of the pubis, the other under the sacrum. In this way the lines of current pass through the pelvis in a sagittal direction. This method, although extremely useful in the treatment of dysmenorrhœa, permits a very moderate amount of heat to pass through the uterus and its appendages, because the degree to which any organ is heated depends on the blood supply to that organ, and the abundant blood supply of the pelvic organs tends to conduct away the heat generated in them by the passage of the current. Also, the two plates not being directly opposite each other, and not in parallel planes, there are certain angle effects which take off from the heat distributed to the organs between them.

The intervening structures on both sides of these organs, skin, fat or bone, tend to become superheated, and thus deprive the organs themselves of heat. For these reasons the external method is useless in treating infective conditions of the pelvic organs.

2. **The Vaginal Method.**—Here a cylindrical, or better, an ovoid, electrode with a circumference of 20, 25 or 30 mm., on an insulated stem is introduced through the vagina and good contact made with the cervix. The best indifferent electrode both in this and intra-cervical methods is a belt of sheet lead devised by Professor Kowarschick, of Vienna. This is placed round the pelvis and closed over the symphysis by a simple screw or pin clasp, carrying a lead attached to one of the poles of the diathermy machine, the other being attached to the vaginal electrode. Carefully adjusted, this belt secures a more equal distribution of the lines of current that radiate out from the active vaginal electrode. This method is very useful in the treatment of amenorrhœa, also as a preparatory treatment in the cases of vaginitis and salpingitis, whether gonococcal or non-gonococcal in origin, with spread of infection to tubes and ovaries. If treated directly by application of diathermy or constant current to

the cervix and uterus, these cases are apt to flare with the exhibition of constitutional symptoms and much pelvic pain. In fact, they have been considered hitherto as a contra-

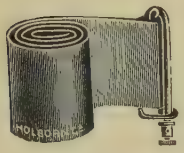

Fig. 35.—Belt electrode.

Fig. 36.—Vaginal electrode, vulcanite and metal.

indication to any form of electrical treatment. But if a few preparatory treatments of vaginal diathermy are given as a prelude to intra-cervical diathermy or ionisation, these exacerbations will be prevented and the treatment itself will be more effectual.

3. **The Rectal Route.**—This method is used to apply heat to the interior of the pelvis in children and virgins where no speculum can be passed. It is also extremely useful in the treatment of chronic parametritis with exudate in Douglas's

Fig. 37.—Rectal electrode.

pouch. Here one electrode is passed into the rectum, the other being again the leaden pelvic belt. If the temperature is taken in the rectum by a hollow metal electrode, it is found that adults will tolerate a temperature up to 114° F. At that point the sensation of heat becomes one of pain. The current is then slightly reduced and the treatment kept up at that heat for twenty minutes. Children stand this treatment well, and the writer saw one of Cumberbatch's and Robinson's most striking cases—a child of seven with urethritis and a vaginal discharge and acutely painful gonococcal arthritis of wrist, which completely cleared up during a course of six or seven such treatments ; she lost her arthritis, the discharge in

which gonococci had been found ceased, and future bacteriological examination proved negative, although no results had been obtained by a previous and prolonged course of douching in the wards. Drs. Robinson and Cumberbatch have published a series of 100 such cases successfully treated on their lines, and there is no doubt whatever in the minds of those who have adopted their technique and instruments, which can be obtained from The Holborn Surgical Instrument Co., Ltd., 26, Thavies Inn, London, E.C. 1, that, of all the various methods in vogue for the treatment of gonococcal infection of urethra and cervix, diathermy, if applied in this way, yields the most rapid, sure and effectual results.

It is true that the failure to find the gonococcus in these cases is no proof that the organisms are destroyed, and that they may not still be lurking in pockets, recesses and in the tissue depths. But if repeated bacterial examinations prove fruitless, if profuse and purulent discharges decrease in amount and become mucous and clear, and if at the same time a severe peripheral arthritis clear up without any local treatment, it is reasonable to attribute the cure to diathermy.

The success of such treatment depends on two things—firstly, rigid surgical asepsis ; secondly, it should be given only by medical men or women with some knowledge of gynæcology and trained in the application of high frequency currents. Haphazard amateur and sketchy methods not only result in failure, but are the cause of very serious damage to the organs.

4. Method of applying Intra-urethral and Intra-cervical Diathermy

In dealing with cervical infection the treatment of the urethra is of paramount importance, as will be shown. The patient lies on the couch with pelvic belt adjusted. The sterile active electrode, a small metal tube $\frac{3}{16}$ in. in diameter, is passed into the urethra for $1\frac{1}{2}$ in., and the current is turned

on. The urethra is sensitive to heat, and here, as in the rectum, it is found that at about 114° F. the sensation of heat changes to pain. The current strength at that point is noted ;

Fig. 38.—Urethral electrode.

it is reduced to toleration point and kept flowing for ten minutes.

The cervix is then treated—a speculum is passed, and a metal electrode of the same diameter as the urethral one and sheathed in rubber up to within $\frac{3}{4}$ in. of the tip is passed through the speculum into the cervical canal. At this stage two difficulties are encountered. The first is the difficulty of obtaining a presentation of the external os. The second is the difficulty of gauging the strength of the current necessary to heat the insensitive cervix to the lethal temperature of 114° F.

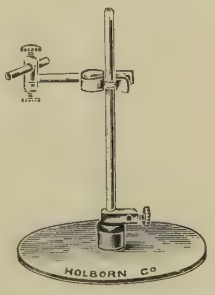

Fig. 39.—Stand, made of brass, nickel-plated, with adjustable rod and sliding slip for fixing instruments in position during treatment.

The first is overcome by raising the pelvis on a sandbag ; this alone is often enough to ensure a good view of the cervix : if not, a Brewer's speculum with unequal lips is used and gently manipulated till the os presents. In more difficult cases still a speculum with obturator can be used. When the latter is withdrawn the cervix falls into the end of the speculum.

The second difficulty, which was a very real one, often resulting in severe burns of the cervix, has now been overcome by Drs. Cumberbatch and Robinson, who use the sensitive urethra as standard for the insensitive cervix. By

making their cervical electrode of the same diameter, but half the length of the urethral, the area of contact between electrode and tissues in the cervix is half that of the urethra. If, then, the current that flows through the cervix for ten

Fig. 40.—Graduated pliable electrode, of tin alloy, with removable two-way connection.

minutes is half as strong as the current applied to the urethra, the current density and the temperature in urethra and cervix will be the same. This method of gauging the strength of the current that will heat the cervix to the lethal temperature of 114° F. can be demonstrated to be correct by using hollow

Fig. 41.—Vaginal speculum, with suction obturator, which draws the cervix into the speculum.

electrodes containing thermometers. It is entirely trustworthy and so reliable that in practice it is found that the thermometers can be dispensed with, the patient's sensation of heat in the urethra being a perfectly reliable guide for the current strength to use in the cervix. But it is absolutely necessary to treat both urethra and cervix at each sitting. The treatments, however, being short and painless, are well tolerated by patients, especially as it seldom is necessary to give more than six or eight. By then the signs of infection will have disappeared, the cervix is no longer red, large and hard, and any accompanying arthritis, if recent, will have cleared up. If of very old standing, it will have improved so much that joints that were so acutely tender that they could not be handled, can now be treated by manipulations to restore function.

Ultra-Violet Rays in Gynæcology

Treatment of Erosion

Some workers have claimed good results in the treatment of erosion of the cervix by using ultra-violet rays from small arc lamps with long tubes for conveying the light into the vagina, but as erosion of the cervix is the outward and visible sign of an infected cervical canal, and as the ultra-violet rays are incapable of penetrating more than one-tenth of a millimetre, they cannot reach the uterus or cervical canal in this way.

The Kromayer lamp, with its quartz applicators, specially made to enter the body cavities, gives very much better results and is exceedingly useful in the treatment of these tedious mixed infections. Ultra-violet light is bactericidal in superficial conditions, and by this method it can be brought into intimate relation with the infected mucous membrane. There are, however, objections to the Kromayer lamp. It is a complicated apparatus with extensive water-cooling arrangements which make it very expensive, and it gets out of order very quickly. The writer can recommend for use in this field a much simpler lamp, the small "*lampada Italiana*," brought out by the late Professor Arnone of Florence, a distinguished pioneer in actino-therapy. It is a carbon arc lamp with specially impregnated carbons and beautifully made quartz applicators for cervix, nose, etc. It is compact and portable.

Treatment given by it has been found successful in the erosion of the portio vaginalis and leucorrhea, and is invaluable in pruritus vulvæ and some eczematous conditions.

As regards the use of mercury vapour lamps in pelvic conditions Fromme has recently published an interesting series of twenty-three cases of pyosalpinx treated by ultra-violet radiation with dramatic results. Impressed by the success of local treatment of the abdomen in cases of tubercular peritonitis, he determined to try it on chronic inflam-

matory conditions of tubes and ovaries and selected cases of chronic pyosalpinx with involvement of the pelvic connective tissue and peritoneal adhesions to the organs. All these patients had abnormalities of menstruation, premature, profuse, or painful. On examination all had infiltrations and thickened tubes, while thirteen of them had varying degrees of palpable pyosalpinx, some the size of the fist. Only the lower abdomen was treated, care being taken to screen off the rest of the body. The exposures began with one minute and were gradually increased to twenty, while the distance from the lamp (of the Hanau-Jesionek type) was 75 cm., gradually decreased to 40. Out of the twenty-three thus treated, only eleven continued the treatment to the end, but of those, nine were completely cured after about fifteen such treatments, losing all their symptoms and objective signs. This brilliant result was achieved in the out-patient clinic, no other treatment being given. There were no bad results or complications. A few complained of erythema, while most of them had slight rise of temperature following treatment and due to absorption.

The writer has had some opportunity of applying ultra-violet radiation to gynæcological conditions, and is convinced that it is a therapeutic agent of great importance. No one who has worked much with ultra-violet light can fail to be struck by its effect on the pelvic blood supply. In treating cases of anæmia and other conditions by general quartz light baths, it is found that the menses occur rather earlier than normal; dysmenorrhœa of old standing is relieved, amenorrhœa is influenced, and the troubles of the menopause are minimised.

Notes of two recently treated cases showed that these baths are also invaluable in post-operative treatment and in tardy convalescence. Two women who had sustained large losses of blood from long-standing menorrhagia and metorrhagia and who had in consequence cardiac symptoms and much exhaustion, recovered in a comparatively short time

without the administration of iron which could not be tolerated in any form. In one case the hæmoglobin went up from 40% to 70% in three weeks, with a marked increase in the leucocyte count, the red blood count increasing much more slowly. Both cases had dyspnœa, œdema, albuminuria and tachycardia –one had a large soft horizontal heart with a rate of 100 lying, and 130 on standing. There was much limitation of the field of cardiac response and the electro-cardiagram was subphysiological with flattened-out and almost isoelectric curves. In the other case exercise produced arrythmia which the electrocardiagram showed to be left-ventricular extra-systoles. It also showed a sign of graver significance, inverted T waves in all three leads. Both these anæmic and exhausted hearts recovered their tone rapidly under treatment by ultra-violet radiation. In seventeen treatments in the one case given thrice weekly, and twenty-five in the other, all signs of cardiac inefficiency disappeared and the electro-cardiagram became physiological.

The Galvanic Current in Gynæcology

A brief consideration of a few of the physiological effects of the galvanic current help to emphasise the essential points in applying it to gynæcological conditions.

The first is *cataphoresis*, the well-known phenomenon of transference of fluid from the positive to the negative pole that accompanies the passage of the constant current through a conducting medium. This phenomenon indicates a valuable means of using the constant current at the positive pole for the removal of excessive fluids, that is to say, œdema, and exudate from the tissues.

The second is connected with what is known as *analectrotonos* and *katalectrotonos*. These terms recall the old laboratory experiment of passing an exciting current through a muscle nerve preparation through which a constant current is already flowing and noting the weaker muscle response

when stimulus is applied near the anode and a stronger response when near the kathode. Here again, if precautions are taken to prevent ionic concentration and the formation of false kathodes, we can make valuable use of this difference in polar effect. At the anode we find that fluid is transported away and that the nerve excitability is lowered while muscle tends to go into comparative relaxation. At the kathode, on the other hand, the tissue fluids accumulate, nerve ends are responsive to stimuli, muscle increases in tone. Applying this to gynæcological conditions we find that the anode is drying, hæmostatic, anæsthetic, and that it tends to narrow and contract the vessels. At the kathode we shall get hyperæmia, stimulation of the circulation of the glands, increase in nerve sensibility and muscle tone. Alkalies also tend to collect at the kathode and, as pus and exudates dissolve in these, the negative pole may be used for the removal of thick plugs of mucous which often obstruct the cervical canal and prevent the effectual treatment of erosion, etc., by zinc and copper ions which are kations and must be applied to the positive pole. If, then, the kathode is first applied, a thick purulent discharge will become thin and clear, and a more active hyperæmia is induced. Then the polarity can be changed, whereupon the metal ions, instead of merely depositing as an albuminate, are brought into intimate contact with the septic surfaces and exercise their antiseptic and tonic effect.

Success in the treatment of most of these conditions depends on the one hand, on correct diagnosis. The cause of each symptom must be understood. The importance of bacterial examination must never be lost sight of. It is only by close co-operation between gynæcologist, bacteriologist, and electrotherapeutist that knowledge will be advanced. On the other hand, much depends on the right use of the constant current. This is no haphazard matter, and requires judgment and much experience. There is no doubt that much of the good effect of the galvanic current is due

to its tonic, refreshing and trophic effect on involuntary muscle fibres. It is that which overcomes inertia in sub-involution and hæmorrhagic conditions. It also relieves congestion and increases the lymphatic flow.

The sinusoidal current is also extremely useful in chronic endometritis, causing as it does slow contraction of the uterine muscle.

In applying the constant current to the cervical canal and uterus there are technical difficulties to overcome as in diathermy. Here, again, absolute asepsis is the only safe path. It is not always easy even for a skilled gynæcologist to introduce the electrode through a speculum. It often requires skill, patience, and the softening effect of the negative pole which will sometimes introduce it painlessly in cases where it seemed impossible to insert even the smallest sound with the positive pole. Another difficulty is the presence of a wide-mouthed os with eversion and possible erosions. A Kromayer quartz lamp is not always present, and we may have to depend on zinc and copper ions only. Here the ordinary electrodes are no good, as they do not give even contact with the whole surface.

The late Dr. Sloan of Glasgow, the pioneer in this country in the application of electric currents to the interior of the uterus, got over this difficulty by wrapping cotton wool round his electrode. This was soaked in a 2% solution of Zn or Cu sulphate which also filled the glass speculum, but the writer has had better results by using rubber-sheathed electrodes with larger bare zinc or copper heads made to screw on and to fit the everted lips of the opening. These are cheap and quite easy to make. They give far better contact and never cause burns as the fluid method did.

Finally, in treating obstinate cases of endo-cervicitis and endometritis that refuse to clear up with the constant current it is well to bear in mind that most cases of stubborn uterine catarrh are probably gonococcal in origin, even if the history be negative, and the organisms found of doubtful

origin. These cases will clear up rapidly if diathermy is given.

Chronic Parametritis

One of the most important indications for diathermy is in the treatment of chronic parametritis, especially that slow form of inflammation accompanied by progressive sclerosis with thickening of the connective tissue under the peritoneum of Douglas and round the posterior fornix. This begins with œdema and exudate into the pouch of Douglas. The sacro-uterine ligaments are lengthened and the cervix descends, while the fornices bulge into the vagina, rendering the passage of a speculum difficult. This stage is followed by a progressive infiltration of the cellular connective tissue. The utero-sacral ligaments then shorten and thicken, and there follows a marked limitation of movement of the cervix with retroversion. The chief symptoms are headache, intractable backache with cervical catarrh. Examination causes much pain which is felt in the rectum, and it reveals a complete want of the normal elasticity and mobility of the cervix, while the utero-sacral ligaments are felt as sclerotic cords.

The treatment for this is diathermy, which fulfils a twofold task in the treatment of this chronic and painful condition. Firstly, it relieves all subjective discomfort and pain, the first treatment causing immediate relief during, and for several hours after. All the pain gradually disappears under the influence of this deep sedative heat. With the ensuing vasodilation there is also an increased blood supply which improves the nutrition of these hardened, starved tissues, while the lymphatic flow is promoted.

Some judgment is necessary to decide upon the best moment to apply diathermy. The indication in parametritis for through heating of the tissues is after the acute stage is passed ; apart from the fact that fresh exudates tend to disappear with rest only, the application of such heat given

too early, may lead to undesirable complications such as the starting off of hæmorrhage or an acute flare-up with pain, temperature and general symptoms, but, applied at the right moment in subacute and chronic cases, it is of great benefit. Under its influence the tender thickened ligaments become anæsthetic and stretchable, and pain disappears. Much, however, still remains to be done. Adhesions must be stretched, fixations loosened, mobility must be restored and displacements must be corrected. Diathermy cannot do these things unaided. To reinforce its effects recourse may be had to physiotherapy in the form of special bi-manual vagino-abdominal manipulations, known as Thure Brandt's bi-manual treatment and practised by him and Dr. Hellebore in Sweden with brilliant success. This treatment is stimulating to the circulation, the vessels being contracted by a mechanical stimulation, while the lymphatic drainage becomes freer. It also increases the tone of uterine muscle and the enlarged organ becomes reduced in size while its mobility increases as the parametric bands on its posterior surface are stretched. This form of treatment has never had much vogue in England, but it is more resorted to in France and in Sweden. The writer learnt it in the latter country and has used it with success for many years, not only in the treatment of parametritis but in endometritis with profuse and painful periods, while, in conjunction with diathermy in some cases of fixation and displacement, it often gives better results than operation. It is also useful in some cases of amenorrhœa with small and under-developed uterus. Here it can be done entirely by the rectum. The sittings are very short, six or seven minutes only. Each consists of :

1. A few movements of Brandt's special abdomino-vaginal manipulations, which are chiefly vibrations ;
2. Extension movements for the treatment of fixations and adhesions of uterus, tubes and ovaries ;
3. Gentle replacement and lifting movements to the uterus,

and lastly, a few gymnastic movements to improve the pelvic circulation and strengthen the muscles of the pelvic floor.

To be successful in this treatment the operator must have strict asepsis, some knowledge of gynæcology and a thorough mastery of Brandt's technique, which is scientific and precise. In skilled hands it is painless and free from risk. Preceded by diathermy in all conditions uncomplicated by hæmorrhage, it yields unrivalled results in the treatment of parametritis with adhesions that have not yet become too sclerotic.

Amenorrhœa

The causes of amenorrhœa are many, and not all of them are amenable to electrical treatment and radiation. In young girls amenorrhœa is often associated with a general hypoplasia or infantilism depending on some interference with the energy and development of the ovaries, or the ovaries themselves may be adversely influenced by chlorosis or by organic or functional disturbance of the hypophysis. Two factors have to be considered in treatment, viz., the general and the local. Improvement in the general physical condition will be gained by endocrine therapy, hygiene, air, exercise. The fundamental part of the local treatment is to increase the blood supply and hyperæmia in pelvis and uterus. This can best be done by frequent treatments of diathermy, given alternately by the rectal and vaginal routes, and by ultra-violet baths. Brandt's manipulations are of value given after these, as after diathermy. The general light baths are excellent for improving the general condition and removing the depression that often accompanies amenorrhœa. Their marked effect on the pelvic blood supply has already been noted.

Dysmenorrhœa

Dysmenorrhœa is again a symptom due to many causes, some of which are difficult to decide as they show no palpable

lesions. A correct diagnosis of the cause is of course the essential precedent to any rational treatment by electricity or radiation. In cases of true uterine dysmenorrhœa due to chronic inflammatory processes, in some forms of obstructive dysmenorrhœa, and in that due to undeveloped uterus, as well as in tubal or ovarian dysmenorrhœa due to inflammatory changes, the penetrating heat and sedative effect of the diathermy current are invaluable.

Ultra-violet radiation has also given good results here, especially in the treatment of cases due to chronic inflammatory changes.

In conclusion, there is a wide field for original research in the treatment of gynæcological conditions by electrotherapy, especially in the domain of diathermy, and in the field of ultra-violet therapy which is coming into its own as a therapeutic agent of great importance in gynæcology.

CHAPTER XIV

RADIUM IN THE TREATMENT OF CARCINOMA OF THE CERVIX

By MALCOLM DONALDSON, F.R.C.S.

Introductory Remarks

It is only of recent years that the treatment of malignant disease by radiotherapeutic methods has been extensively tried in this country. When it was originally discovered that malignant tumours diminished in size and even disappeared if treated by such methods, it was thought by many that the cure of cancer had been found. Later, however, when it was realised that the patients died of the disease in more distant sites, opinion veered round to the other extreme, and people lost faith in all radiological methods before the subject had been thoroughly investigated or new variations of technique had been tried. It should be remembered that radiotherapeutic science is in its infancy, and that the results already obtained are so striking that it would be an enormous mistake to abandon such treatment. To say the least, it is the most valuable palliative method that we have in the treatment of inoperable carcinoma of the cervix, and there are indications that with improved technique it may in time supplant the more drastic method of Wertheim's hysterectomy in the early cases. In some clinics in America and on the Continent this has already taken place.

Another factor which has tended to bring this treatment into disrepute is the haphazard way in which radium has been used. Too many medical men look upon radium as a

drug with only one method of application, the amount of dose being indefinite and unimportant. Further, the value of the treatment is gauged entirely by the number of years the patients survive, and its palliative value has been lost sight of. As will be seen in a later paragraph, the failure to prolong life has so far largely been due to the inability to bring the radium near the more inaccessible parts of the growth, which, of course, continue to grow and kill the patient as heretofore.

Radium

Radium is obtained chiefly from pitchblende, of which ore deposits are found in the Belgian Congo, Colorado, and in Cornwall. Only minute traces of radium are present, so that many tons of the pitchblende have to be treated in order to obtain a gram of the element. The element itself is always used in combination as a salt, such as the bromide or the sulphate.

Description.—The element radium has an atomic weight of 226·5, and is a very remarkable substance, as it is continually breaking down into bodies of a lesser molecular weight, although the mass of the radium proper only diminishes by 50% in 2,000 years.

Radium element first breaks down into a gaseous state at atmospheric pressure and at ordinary temperatures, with the expulsion of alpha particles. This gas is called emanation or radon, and has an atomic weight of 222. The life of emanation gas is a short one, as it, in turn, breaks down into radium A, at the rate of one-sixth of its volume each twenty-four hours, so that in slightly less than four days it has become half its original value.

Radium A, which has an atomic weight of 218 breaks down into Radium B, with an atomic weight of 214, and this again into Radium C and C′.

Radiations.—The radiations given off from these various bodies are not all of the same nature. Radium element itself gives off alpha particles and beta rays.

Alpha Particles.—These are comparatively speaking large, slow-moving bodies which have very slight penetrating power, and can be stopped by means of a piece of cigarette paper, or even a few centimetres of air. These alpha particles are really atoms of helium positively charged, and have an atomic weight of 4. They are not used in gynæcological treatment, as the radium container always intercepts them.

Beta Rays.—These are far more penetrating than alpha particles, travelling at a velocity approximately that of light, but are almost entirely stopped by a filter of 0·5 mm. platinum and are little used directly as a gynæcological agent.

Gamma Rays.—It is not until we get to the body Radium B and Radium C and C′ that we obtain any of the very penetrating radiations known as gamma rays. These rays are of the same nature as other ether waves, but the wavelength is very much shorter. They vary in length, but the longest of them—that is, the softest and least penetrating—are one-third the length of the shortest and most penetrating waves obtained from an X-ray apparatus using 200,000 volts. Expressed in another way, we can say that they are twenty-seven times as hard and as penetrating. It is these gamma rays that are chiefly made use of in the treatment of malignant disease.

Secondary Radiations.—When gamma rays strike any metal with a high atomic weight some of the rays are absorbed, others are scattered, and, in addition, secondary radiations are given off from the metal. These secondary radiations are of a longer wavelength and not so penetrating as the original ray.

METHODS

Forms of Radium.—In treating a case with radium it is possible to use either the solid salt such as radium sulphate, or to draw off the emanation gas from a solution and use this alone. Whichever method is used, the same radiations are being employed, namely, those from the broken-down pro-

Fig. 42.—Skiagram of needles placed in position per vaginam. The shorter needles grouped in the centre are encircling the cervix. The longer needles on either side are in the base of the broad ligaments.

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ducts of the above, Radium B, Radium C and Radium C′. It must be remembered, however, that when the emanation gas is drawn off and used, the supply of gas is limited and diminishes rapidly every day. When, however, the radium salt is used the supply of emanation gas is in equilibrium—that is to say, it is being replaced as rapidly as it breaks down into Radium A and Radium B, etc.; and, therefore, the supply of gamma rays from Radium B, Radium C and Radium C′ is constant.

Radium Salt.—Various radium salts are used in radiotherapy, but the most convenient is radium sulphate, because its solubility is small, which is important if a leak should occur in the container and water be admitted. Radium bromide is a commonly used compound, but has the disadvantage above referred to.

Forms of Applicators.—The containers in which the radium is applied vary in different techniques and according to the site of the lesion to be treated, but in cases of carcinoma of the cervix the more usual containers consist of needles or tubes.

Description of Needles.—These needles are hollow and are made of various metals, the most commonly used being platinum mixed with a small amount of iridium. When the radium salt is used it is permanently sealed up in these hollow needles, but when the emanation gas is employed a fresh set of small capillary glass tubes containing the gas are placed inside the hollow needles before each application.

The walls of the needles or tubes are spoken of as filters,

Needles.	Length over all.	Active length (mm.).	Thickness of wall (mm.).	Each containing mg. ra. el.	Outside diameter (mm.).
8	59 mm.	47·5	0·5 plat.	3	1·65
12	43 mm.	32	0·5 plat.	2	

because they intercept the alpha particles and beta rays, allowing the gamma radiations to pass. In some cases additional filters are added to the outside of the containers. The writer favours needles rather than tubes, and employs twenty or more needles, having the above dimensions.

Method of Obtaining Emanation Gas.—Emanation gas, as stated above, is being given off continually from radium, and the method employed to obtain it is as follows: A solution of radium is sealed up in a jar and the gas evolved is collected by means of a mercury pump into capillary tubes. The small quantity of oxygen and hydrogen that comes off as an impurity is got rid of by passing a spark through the gas, thus exploding the mixture and forming water. This leaves a practically pure gas consisting of emanation, which is condensed by placing the capillary tube in a quantity of liquid air. The condenser emanation is deposited on the inside surface of the capillary tubes which then has a greenish tint. The tube can be divided up into suitable lengths by means of a fine blowpipe flame, before the emanation has time to return to its gaseous form. These small lengths of capillary tubes can either be used as buried unfiltered "seeds" or placed in hollow metal needles such as platinum, which acts as a filter.

DOSAGE

The subject of dosage is all-important, although authorities are not at present quite unanimous as to the optimum amount of radium that should be used, or the length of time of application. The word "dose" should mean the intensity of irradiation received by the tissues, multiplied by the time during which the radium is applied. The intensity of the radiation received by the tissues varies enormously according to its distance from the course of irradiation. The law governing this variation is the same as that of light, namely, the "inverse square law," that is to say, that if a small source of

radium is removed twice as far from the tissues the radiation falling on a unit surface of tissue is only one quarter of what it was in the original position. To illustrate this it can be stated that the dose received by the fingers when holding a quantity of radium in a small tube the walls of which are 0·5 mm. thick, for five minutes, is equivalent to exposing those fingers to the same quantity of radium at a distance of 1 metre for three and a half years. A more practical way of expressing this is to state that the tissues 5 cm. away from a needle 15 mm. long, the walls of which are 0·5 mm. thick, receive only about $\frac{1}{1,000}$ of the dose which is acting on the tissues immediately adjacent to it. The above examples demonstrate very forcibly the necessity of always using forceps when handling radium, and further, is one of the most obvious explanations why the neoplasm disappears locally but continues to grow at short distances away, with fatal results to the patient.

Units of Dose.—In order to appreciate the descriptions of various techniques the expressions used to indicate a unit of dose must be clearly understood. When radium is used in the form of salt the unit spoken of is 1 mg. radium element used for a certain number of hours. When emanation gas is used, the word millicurie is substituted for milligram.

Recording of Dosage.—At the present time different operators express their dosage in various ways; for instance, some writers simply state it as a number of milligram-hours, and to arrive at this they multiply the number of milligrams of radium element used, by the number of hours for which it is applied. This method can only be of value if it is assumed that 1,000 mg. radium element used for one hour gives the same biological result as 1 mg. used for 1,000 hours; but there is considerable evidence to show that this is not correct. Another method of computation is to calculate the number of millicuries of emanation destroyed during the application. This can be done as follows: In cases where radium element is used the number of milligram-hours are multiplied by

0·0075. In the case where emanation gas is used we know that one-sixth of the emanation is destroyed every twenty-four hours, and, therefore, if the original amount of emanation applied was 100 millicuries, at the end of twenty-four hours 16·6 millicuries would have been destroyed. If the time be increased to forty-eight hours, another sixth of the remaining 83·4 will be destroyed, making 30·5 in all. In seventy-two hours 42·6 will be destroyed, and so on.

In our present state of knowledge it is far better to give in full *the number of milligrams of radium element employed, the number of hours during which the application lasts, the number of needles or tubes, with details of dimensions, especially thickness of the walls of the containers, and, as far as possible, the positions of the same relative to the tumour.*

BIOLOGICAL ACTION OF RADIUM

Unfortunately, the biological action of radium is at present very little understood, but much work is being carried out at various centres. The one great fact that is proved beyond doubt is that under certain circumstances if carcinoma be exposed to radium, the growth in its immediate neighbourhood will disappear. Dr. Canti in this country and Lacassagne in Paris have studied the early histological changes in carcinoma of the cervix uteri following the application of radium. They have come to the conclusion that immediately after a twenty-four hours' application of radium mitosis ceases entirely. A few days later the majority of the malignant cells undergo very abnormal mitosis, which ends, not in the usual daughter cells but as fragments of cells, as if an explosion had taken place, or the nucleus alone divides and the cell undergoes degeneration and dies out. One of the more important clinical problems on which it is hoped that laboratory research will throw some light is whether it is better to give a large dose for a short time or a smaller dose for a long time.

There is a certain amount of evidence to show that tumours

composed of cells undergoing rapid mitosis are more susceptible to the action of radium than those of a more chronic form. This may account for the fact that in a section taken soon after irradiation the malignant cells have obviously been destroyed by the treatment, whilst the connective tissue cells and muscle cells are not injured.

At one of the clinics in France, the length of time for which radium should be applied is calculated on the theory that a cell is only vulnerable during early mitosis. At this institution pieces of tumour are removed and the proportion of cells in mitosis to vegetating cells is estimated. If the proportion of mitotic cells is high the duration of application is short compared to those cases in which the proportion is low.

DESCRIPTION OF TECHNIQUES

Speaking generally, there are two schools of technique, one which believes in application external to the growth, the other which believes in burying the radium close to or in the growth. The arguments put forward for the different opinions can be summarised as follows: Those authorities who advocate external application consider:—

1. That any incision, even the introduction of needles, may disseminate the growth.

2. That the injured normal tissues may be affected by the radium to an undue extent, as it is well known that radium affects cells which are about to go into mitosis.

3. That the tissue extracts produced by injury to the normal cells may stimulate the growth of the tumour.

4. That the burying of the needles may produce sepsis under conditions very suitable for the growing organisms.

Those authorities who advocate the burying of the needles do not consider that these objections are in any way comparable to the advantages of the *greater intensity obtained by placing the needles near the growth and the even distribution of irradiation throughout the tumour obtained by multiple con-*

tainers. Further, they consider that if the radium is used from outside the amount must be so large that there is considerable likelihood of damaging the skin and other intervening tissues. Some of the more important clinics in Paris believe in external application, whilst in Brussels the technique of burying the radium is more often employed. In America both methods are used, and the radium is sometimes inserted in the form of unfiltered glass " seeds " of emanation, thus bringing into play the beta rays. In this country opinion is divided on the subject. The exact technique differs considerably in different institutions, and it is here only possible to indicate the methods in general use, as every centre has its own variations.

Vaginal Treatment by means of Buried Needles.—The main object of this technique is to distribute the radium evenly throughout the tumour. This in the opinion of the writer is one of the most important points in radium treatment. For the convenience of those who have not done much of this work, a detailed description of the technique at present used by the writer for vaginal application may be of value.

The patient is douched for two or three days before the operation with weak lysol. At the time of the operation she is placed under an anæsthetic in the lithotomy position, and the vulva and vagina cleaned with picric acid 3% in spirit. A microscope section is then taken in every case where the radium is applied for the first time. The needles are placed in and round the growth, keeping as far as possible about half a centimetre of tissue between each needle. The longer needles are pushed outwards as well as upwards into the base of the broad ligaments. The whole vagina is then packed with gauze soaked in flavine. The amount of radium used, as a rule, is as follows :—

8 large needles, each containing 3 mg. radium element. Filter 0·5 mm. platinum.

12 or 13 needles, each containing 2 mg. radium element. Filter 0·5 mm. platinum.

Total milligrams, 48 or 50. These remain in place for 144 hours and are then removed. All needles are sterilised by oiling, and care must be taken that no mercury solution comes into contact with the platinum. It is possible that in the near future a greater number of needles will be employed in the vaginal walls, nearer the vulva, to prevent extension round the rectum.

Vaginal Treatment by Surface Application.—The usual routine for this method of treatment is as follows : The vagina is prepared by means of douches, but the growth is not cauterised or in any way interfered with. One or more tubes are placed in the cervical canal containing in all approximately 50 mg. radium element, with a filter of 0·5 mm. platinum ; in the vagina there are more tubes, heavily filtered with 0·5 or 1 mm. platinum, and sometimes these have additional filters of cork or aluminium and rubber to stop the secondary rays coming from the platinum filter. The total amount of radium contained in these vaginal tubes is 25 to 30 mg. of radium element. The exact details of the filters vary at different centres. The duration of application also is a matter of opinion, some authorities advocating twenty-four hours, others as much as a week, or even more. On the whole, the tendency seems to be to lengthen the duration of exposure, and in the opinion of the writer the immediate results in cases treated for 144 hours are distinctly better than those obtained formerly.

Extra-abdominal Application of Radium.—In some clinics, in addition to the above vaginal application large quantities of radium are used on the surface of the abdomen, placed at a distance from the skin. This method has been widely employed in America, where as much as a gram of radium is used at a distance of 10 cm.

Technique for Intra-abdominal Radium.—In order that the more deeply situated growth should be irradiated various techniques have been devised for introducing the radium per abdomen. These can be divided into extra-peritoneal and

intra-peritoneal methods, but in both cases the practical difficulties are very great. The disadvantage of the extra-peritoneal method is the amount of blunt dissection required and, as pointed out previously, the normal tissues undergoing mitosis, as they do during repair, will be affected to an undue extent. The drawback of the intra-peritoneal method is the reaction of the peritoneum, and in some techniques where drainage is employed the danger of infection cannot be disregarded. So far, none of these methods has proved to be entirely satisfactory in the writer's experience, but a brief description of them may be of interest.

The first technique tried by the writer was that described by Daels of Ghent. This consists in putting the radium alongside the iliac glands, but extra-peritoneal, and is carried out in the following manner :—

The patient is put under an anæsthetic in the lithotomy position. An incision is made in the ischio-rectal fossa and blunt dissection with the finger is carried out as far as the spine of the ischium. Another incision is made just internal to the anterior superior spine and a blunt dissection carried out, the finger passing over the psoas muscle and external iliac vessels. A tube is then passed from the lower incision right through the pelvis to the upper incision and through this tube a chain is guided, the tube being then removed and leaving the chain in position. One radium tube is attached to this chain, which is pulled on, and the desired depth can be obtained by counting the number of links of the chain remaining outside. The radium is moved each day, and entirely removed at the end of the third day (see Figs. 43 and 44).

The weak points of this technique would seem to be that the radium is concentrated in one small area, and does not conform to the fundamental rule that the irradiation should be uniformly distributed throughout the tumour. Moreover, it involves a great deal of blunt dissection with the finger, giving rise to crushed tissue and consequently a risk of infection.

Fig. 43.—Skiagram showing the tubes of radium attached to the chain and in position.

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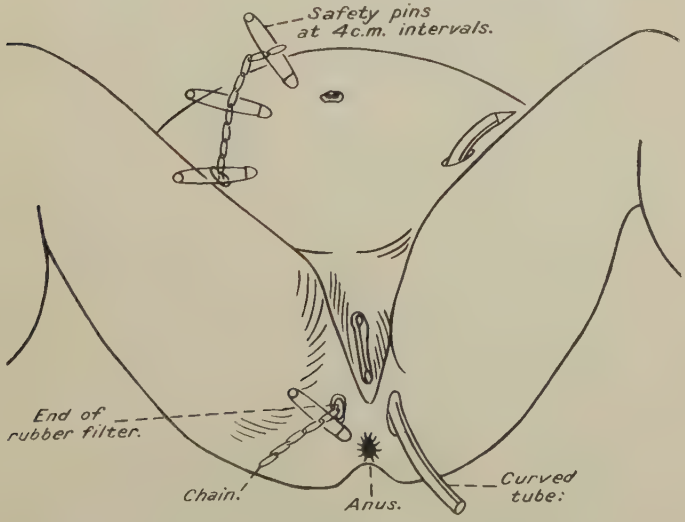

Fig. 44.—On the left of the patient the tube is in position ready to receive the chain. On the right of the patient the tube has been removed and the chain pulled into position.

By permission of the Royal Society of Medicine.

The next technique to be tried was the intra-peritoneal method, which was devised at the Radium Institute of Brussels. To carry out this method the patient is put in the Trendelenberg position and the abdomen opened. Needles are then placed in the back of the uterus and in the broad ligaments, and the rubber-covered wires holding them are brought out through the lower part of the abdominal wound. The whole pelvis is then packed with gauze (it generally requires about 8 yards of 6 in. gauze), and the end of the gauze is brought out with the above-named wires. At the end of a week the gauze and wires are pulled out, the patient being given gas anæsthesia. The results of this technique were somewhat more encouraging, but there is no doubt that the foreign body plus the radium in the peritoneum gives rise to a very marked reaction with the outpouring of much peritoneal fluid.

Combined X-Ray and Radium

This method is now being very extensively used on the Continent. Carcinoma of the cervix is treated by radium per vaginam, and a few weeks later the iliac glands are irradiated with the penetrating X-rays obtained from a modern instrument working with 200,000 volts. The reports from some of these centres are very favourable, and this is borne out by a few cases in the experience of the writer.

Combined Radium and Hysterectomy

For some years the writer has irradiated all operable cases before doing a hysterectomy. At certain centres, Taylor and Peighton state in a recent paper, the number of cases free from recurrences three years after operation has risen from 24% to 44% since adopting preliminary irradiation.

RESULTS OF TREATMENT

As a palliative measure there is no question whatever that radium treatment has already more than justified itself. As

a curative agent it has only been adopted in a few clinics in preference to Wertheim's operation. The symptoms of hæmorrhage and discharge cease within one or two weeks. The growth in the vagina disappears at the end of five or six weeks, and ulceration, if present, will heal in about the same time. Owing, however, to the inaccessibility of the greater part of the growth life is not always prolonged. Taking the results in more detail, they may be divided into :—

(*a*) Histological Findings.
(*b*) Disappearance of Symptoms.
(*c*) Prolongation of Life.

(*a*) **Histological Findings.**—From the investigations into the histology carried out by Canti in this country, the following conclusions were drawn :—

1. That the introduction of approximately 170 mg. of radium element in and around the cervical tissue for twenty-four hours is capable of causing a complete disappearance of the growth within a few weeks, whereas the same application for eight hours produced little or no effect in the quantity or appearance of the growth.

2. That definite series of changes in the carcinoma cells can be demonstrated after irradiation, leading up to complete destruction of the cell.

3. That little or no effect has been produced in affected iliac glands when the cervix is irradiated.

4. That as changes in the malignant cells take place before the formation of fibrous tissue, the latter is not the causal agent in the disappearance of growth.

5. That the carcinoma cells are more vulnerable than the uterine musculature, but in the latter local atrophy and fibrosis takes place at a later date.

In one case where hysterectomy was performed as early as four weeks after the first application of radium, no growth was found in spite of a number of sections being cut and examined, and in the other hysterectomies (some of them performed at the end of a week, others after several weeks),

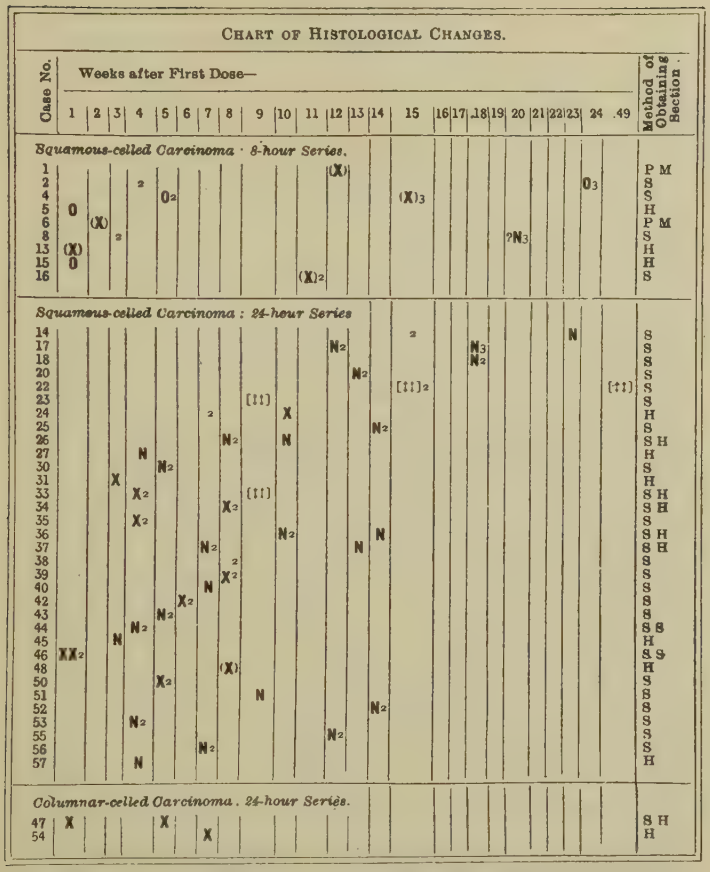
Chart of Histological Changes.
Case No.
Weeks after First Dose—
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 49
Method of Obtaining Section.
Squamous-celled Carcinoma · 8-hour Series.
Squamous-celled Carcinoma : 24-hour Series
Columnar-celled Carcinoma . 24-hour Series.

N.B.—Some cases are omitted from the above series because the patient refused further examination, and a few because no section was obtained before treatment.

Explanation of Signs.—**0** = No change found. **(X)** = Slight changes found. **X** = Marked changes found. **[!]** = Growth scarcely recognizable. **N** = No growth found. P M = Section obtained *post mortem*. H = Section obtained from hysterectomy. S = Section obtained from snipping. The small figures 2 and 3 denote date of second and third doses respectively

For amount of radium used see text

FIG. 45.

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if growth was found at all it was so affected as to make it impossible to believe that the cells would have been viable (see Chart). It will be noted that the above investigations

were carried out on patients treated by the technique formerly employed; the results obtained recently are even better. Other workers in this field have confirmed the disappearance of growth in the uteri removed by hysterectomy. (Fig. 45).

(*b*) **Disappearance of Symptoms and Signs.**—1. *Hæmorrhage.*—In a series of 80 cases treated by the writer and in which this symptom was noted before and after treatment, hæmorrhage ceased entirely in 68 (85%), though in some of these cases hæmorrhage returned shortly before death. But the mental effect on the patient of the cessation of hæmorrhage in itself would be sufficient to justify the use of radium in these cases.

2. *Ulceration.*—In a series of 68 cases in which the carcinoma took the form of ulceration rather than the proliferative cauliflower type, in 43 patients (63·2%) the ulceration disappeared entirely, either temporarily or permanently.

3. *Growth.*—In a series of 37 cases in which the disease took the form of a raised cauliflower growth, in contradistinction to ulceration, in 26 patients (*i.e.*, 70·2%) the growth entirely disappeared.

4. *Pain.*—This symptom is very variable, and one on which it is difficult to get reliable statistics. Occasionally, the relief given by radium is very remarkable. In some cases, however, considerable pain follows the insertion of radium. This latter, when it occurs, generally comes on ten days or a fortnight after the treatment and lasts two or three weeks.

(*c*) **Prolongation of Life.**—As mentioned above, life has undoubtedly been prolonged in a number of cases, and it is perhaps worth while to quote in detail statistics from various centres.

INJURIOUS RESULTS

Fistulæ.—Although certain dangers are incurred in the use of radium, yet the harm done has been very much exaggerated by some people. The reason for this is not far to seek, as it is

sometimes difficult to differentiate between the effect of the radium and the effect of the original growth. For instance, if a visit is made to the infirmaries and homes for incurables, it will be found that quite a large proportion of patients suffer from fæcal and urinary fistulæ a short time before death. When a patient who has been treated with radium develops such a complication this is invariably considered to be the result of the treatment. It is true, however, that if a relatively large amount of radium, such as a 50-mg. tube, is left in contact with the vaginal wall, ulceration may take place, but this can easily be avoided by using smaller doses more evenly distributed, and packing the vaginal wall with flavine gauze.

Radium Burns.—The epithelium of the cervix and vagina is not as sensitive as that in other parts of the body, and the risk of burns is therefore very much less. Should a burn occur, it will appear as a whitish slough, whereas the rest of the epithelium looks healthy. These burns take many months to heal.

Sepsis.—This is a real danger, but can be prevented to some extent by cleaning the vagina by douching and even by ionization. In very extensively foul and ulcerated cases it is perhaps better to use surface application rather than needles, thus avoiding the risk of carrying infection into the deeper tissues.

Stimulating Dose.—There is a considerable difference of opinion as to whether a dose insufficient to kill the cell stimulates it to further activity. As was seen in the paragraph on the Biological Action of Radium there is at the end of three or four days a great outburst of abnormal mitosis, but this only results in the formation of abnormal cells, which rapidly break up. It is possible, however, that in some cases patients, in whom the disease is very advanced and who are very emaciated, undergo a still further lowering of their resistance, resulting in an increase in the rate of growth.

The Spreading of Malignant Cells.—It is difficult to believe

that malignant cells can be spread by the introduction of radium, as those pieces of tissue which are pushed along by the needle must inevitably be destroyed by the radium inside the needle.

STATISTICS FROM SOME OF THE CENTRES

St. Bartholomew's Hospital

In a series of 85 *cases* treated from May, 1921–25, 74 were hopelessly inoperable, 5 were borderline, 6 operable but for various reasons were not operated upon. Of these 85 cases, 31 are living and 54 have died. As, however, some of these living cases have only been treated for a few months the real facts are better expressed by taking those cases who were treated between May, 1921 to May, 1924.

Of 58 *inoperable cases*, 10 are living after one year or more, making 18·9%. These patients have lived one for 48, one for 43, one for 40, one for 21, one for 19, two for 17, and three for 12 months.

Of 4 *borderline cases treated*, one has lived for sixteen months.

Of 2 *operable cases treated* within the same period, 1 has been living for twelve months. Taking these three classes, comprising 64 patients, there are 12 living from one to four years, making 18·7%.

Of the 54 *cases who have died*, 14 lived for one year or more, 1 lived for thirty-six months, 1 for thirty-one months, 1 for twenty-six months. All the 14 were materially benefited for a considerable time, and there is little doubt that their lives were prolonged. Of the remainder, 27 were benefited and made more comfortable for a time, but there is no evidence that their lives were prolonged.

The Radium Institute of Paris

The Radium Institute of Paris published statistics of cases treated 1919–20–21. During this time 226 cases of carcinoma

of the cervix were treated solely by radiological methods. Of these :—

Twenty-one cases were recurrences following operation.—Two of these are free from recurrences (1 was treated by X-ray as well), 3 are living but have recurrences, 16 are dead. In this report Professor Régaud states that in his opinion preliminary hysterectomy causes radium therapy to lose all the anatomical conditions for its efficiency, and, moreover, is liable to scatter malignant cells.

One hundred and fourteen inoperable cases.—Fifteen of these appear to be without any recurrences, the longest being three and a half years, the shortest one year, making 13·2%. 12·4% were greatly benefited.

N.B.—In 1919 and 1920 every single case that could reach the Paris Institute was treated. Since then the inoperables have been selected slightly, as it was found that when very far advanced the treatment did more harm than good. The authors of the Paris Report consider that X-ray only is better for these cases than radium.

Sixty-seven cases were borderline.—Of these 24 are still living, the time since commencement of treatment varying from one to three and a half years, making 35·8%. 35·8% were greatly benefited.

Thus at the end of 1922, 53 cases out of 226 treated were free from recurrences, making 23·4%, 12 being treated in 1919, 22 in 1920, 19 in 1921. Some guide as to the improvement in results can be obtained by taking the number of cases free from recurrences at the end of one year. In the case of the inoperables this is partly accounted for by the improvement in technique, and partly by the fact that the worst cases were not treated. The percentage free from recurrences at the end of one year has risen from 9·2 to 26·3 %. For the borderline cases (in which the technique alone can account for improvement), the percentage has risen from 36·8 to 43·7%. In the operable cases those free for one year in 1920 were 50%. Those free for one year in 1921 were 63·6%.

The authorities consider that improvements in technique are largely responsible for this increase in good results. The permanence of the cure cannot yet, of course, be stated ; but the fact is that the patients treated in 1919 and found free of growth number 13. At the end of 1920 these were still alive. At the end of 1921 and 1922 they had become 12. Those of 1920, 23 in number, had become 22 at the end of 1922.

L'Institut du Radium de Bruxelles

Of 199 *cases of carcinoma of the cervix to December* 31*st*, 1924—

50 cases were operable.
90 cases were inoperable, but not very advanced.
59 cases were inoperable and very advanced.

Of the 50 *operable cases*—

42% appeared cured, and these were treated over a year ago.
2 of these cases were treated over three years ago.
20% appeared cured, and these were treated under a year ago.
28% have died.
10% are lost sight of.

Of the 90 *inoperable cases*—

30% appeared cured, and these were treated over a year ago.
One patient was treated five years and nine months ago.
26·6% appeared cured, and these were treated less than a year ago.
31·1% have died.
12·2% are lost sight of.

Of the 59 *very advanced inoperables*—

30·15% appeared cured, and these were treated over a year ago.

21% appeared cured, and these were treated less than a year ago.

32% have died.

15% have been lost sight of.

The Radiumhemmet, Stockholm

Of 181 *inoperable cases* treated 16·6% were well after five years.

Of 36 *operable and borderline cases* 40·5% were well at the end of five years.

The Memorial Hospital, New York

In 1915, 15 *inoperable cases* were treated, none of whom was living in May, 1921. *One operable case was treated*, who was still living in May, 1921. No borderline case was treated.

In 1916, 24 *inoperable cases were treated*, one of whom was living in May, 1921. *Three borderline cases were treated*, two of whom were alive in May, 1921. Three operable cases were treated, but none was alive in May, 1921.

In 1917, 41 *inoperable cases were treated*, of whom none was alive in May, 1921. *Three borderline cases were treated*, of whom 2 were alive in May, 1921. *Three operable cases were treated*, of whom 2 were alive in May, 1921.

In 1918, 41 *inoperable cases were treated*, of whom 7 were alive in May, 1921. *Of* 17 *borderline cases treated*, 5 were alive in May, 1921. *Of* 4 *operables treated*, two were alive in May, 1921.

In 1919, 69 *inoperables were treated*, and of these 23 were alive in May, 1921. *Ten borderline cases were treated* and 7

were alive in May, 1921. *Of* 9 *operables treated,* 7 were alive in May, 1921.

In 1920, 92 *operable cases were treated,* and 58 of these were alive in May, 1921. *Twelve borderline cases were treated* and 8 of these were alive in May, 1921. *Fourteen operable cases were treated* and 6 of these were alive in May, 1921.

APPENDIX

Details and illustrations of a few instruments recently introduced into the practice of obstetrics and gynæcology may be of interest. In considering the selection I have had before me the importance of describing only such instruments as are of real and proved value.

A modern tendency in surgery is to multiply the number of instruments with a consequent elaboration of technique. There is a considerable danger in this tendency owing to the unconscious glorification of mere technique at the expense of simplicity and surgical judgment.

The majority of operations can be performed quite satisfactorily with a very few instruments of a simple nature—the fewer and the simpler the better.

Comyns Berkeley's Vulva Retractor (The Surgical Manufacturing Co., Ltd. No. 3965A).

This instrument, of a very simple design, has proved of great value during perineorrhaphy and other vulval operations in securing adequate separation of the labia independently of the assistant. Retraction of the labia by Spencer Wells or other forceps held by the assistant, is always unsatisfactory, inasmuch as the assistant's hands are occupied in an uncomfortable position and the forceps are liable to tear and damage the mucous membrane.

Fig. 46.

Berkeley's forceps are self-retaining, easily adjustable, and do not damage the tissues.

A more elaborate form of vulval retractor has been designed by Blair Bell (made by Thackray of Leeds). It serves the same purpose as Berkeley's, but by reason of its greater complexity is more difficult to clean and more liable to get out of order (*vide infra*).

Jayle's Self-Retaining Vaginal Retractor (The Surgical Manufacturing Co., Ltd., No. 3965).

This is an instrument for retracting the walls of the vagina during operations on the cervix or posterior vaginal wall. By means of the screw any desired amount of separation can be obtained and the instrument remains in position unless the cervix is pulled down excessively.

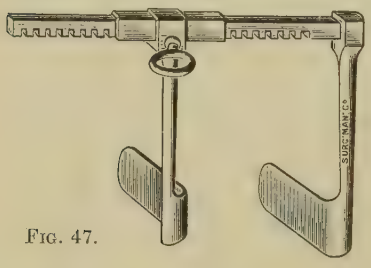

Fig. 47.

Its disadvantages are that it rather tends to limit the amount of action for a difficult operation, like amputation of the cervix; but for mere inspection of the cervix, simple operations thereon, or for the removal of retained products of conception, this retractor is of considerable value. It is perhaps of chief use in operations on the posterior vaginal wall when the ordinary duck-bill speculum would overlay the area of operation.

Artery Forceps with Glendining's Improved Rack (Arnold and Sons).

This forceps differs from the ordinary artery forceps in that the catch arrangement is situated on a rack fixed to the end of the handle rings. Mr. Bryden Glendining writes—"The claims made for the end rack on forceps are:—

"1. A softer, more resilient grip, owing to the number of

teeth on the rack; it is possible to lock with a holding grip which is less than the crushing bite of the ordinary make, and the sensitiveness of this grip is furthered by the greater resiliency or spring arising from the longer shank between the joint and lock rack.

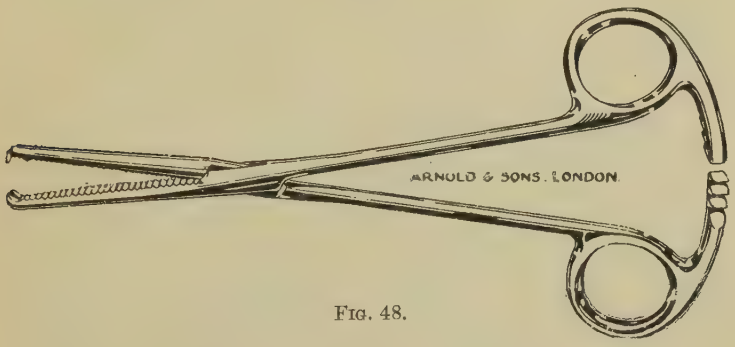

Fig. 48.

"2. Many surgeons are frequently hampered by the suturing material getting caught up between the handles of forceps which are applied to the wound; with the end bow this cannot occur."

Blair Bell's Vulva Retractor (Thackray, Leeds).

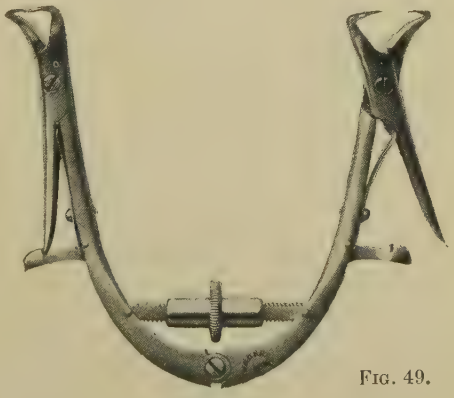

Fig. 49.

This instrument is another form of self-retaining retractor for holding apart the labia, as in the case of Berkeley's Vulva Retractor. It obviates the attention of the assistant being devoted to efficient exposure, and by means of the central screw, an exact amount of separation can be adopted. The disadvantage, however, of this instrument is its com-

plexity ; there are several joints and moveable parts, and it is, moreover, difficult to keep clean and polished.

Bonney's "T" Shaped Vaginal Clamp (Allen & Hanbury).

This instrument is designed for use during Wertheim's operations for removal of the uterus and vagina for carcinoma of the cervix. When the upper part of the vagina is sufficiently freed from the bladder in front, the rectum behind, the ureters and para-vaginal tissue at the sides, the clamp is applied as low down as possible on the vagina so

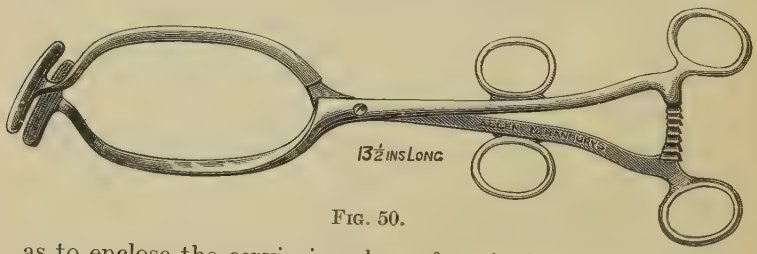

Fig. 50.

as to enclose the cervix in a bag of vaginal wall above. By this means, septic and malignant particles are prevented from escaping into the operation wound as the vagina is cut through. The prevention of contamination of the wound is an exceedingly important point in the technique of Wertheim's operation, and by the great pressure that it is possible to apply by this instrument such contamination is wholly cut off.

Bourne's Vaginotome (Allen & Hanbury).

This knife has been designed for use with Bonney's Vaginal Clamp. It consists of a cutting blade set at about an angle of 66 degrees to a long handle. The blade, moreover, is tilted slightly on the handle so that its cutting edge is directed a little upwards, while the end of the blade is capped by a blunt point. The inclination of the blade to the handle allows a convenient section of the vagina beneath the jaws of the

clamp, so that the cutting edge of the vagina is clean and free from the notches that are commonly seen when it is cut by scissors. The slope upwards of the cutting edge prevents

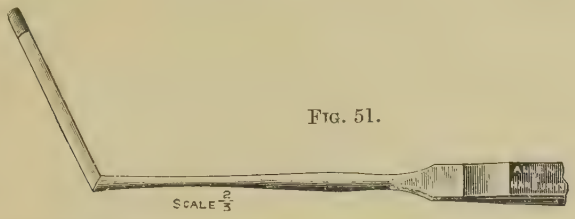

Fig. 51.

the blade cutting down the vagina where it might damage the bladder, and ensures its cutting upwards against the clamp, while the blunt end of the knife similarly prevents injury to the rectum behind.

Bonney's Myomectomy Clamp (Allen & Hanbury).

One of the dangers and disadvantages of the operation of Myomectomy, unless prevented, is the profuse hæmorrhage which occurs from the large face of the capsule. In the case of large tumours this may be of so dangerous a degree as to render the patient blanched, and prevent the removal of

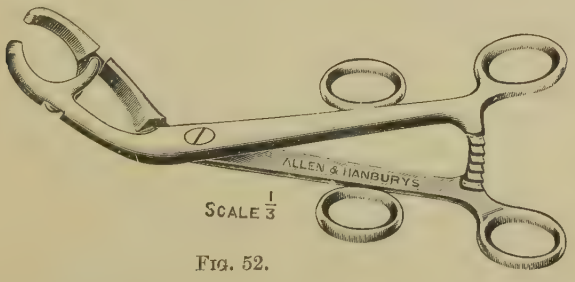

Fig. 52.

further fibroids. By the use of this clamp applied to the cervix, and ring forceps to the infundibulo-pelvic ligaments, it is possible to prevent any bleeding beyond a negligible amount of oozing. The inclination of the jaws of the forceps to the handles is such as to allow the former to be sunk

behind the symphysis pubis in a convenient position for grasping the cervix at the level of the uterine arteries. In order to make sure that the forceps is applied above the point where the arteries reach the uterus, Bonney recommends that the round ligaments with their folds of peritoneum be depressed and included within the grasp of the forceps. In applying the instrument, having manœuvered it so as to include the round ligaments, the forceps is then pushed strongly on to the cervix at the level of the internal os, and closed moderately firmly in order to compress efficiently the uterine arteries.

An extended experience of this instrument has led Bonney to rely on it with complete confidence for hæmostasis, while at the same time he has seen no single case of injury or embolism following it or any other disadvantage attending its use.

The common errors in applying the instrument are :—

Firstly.—That it is applied too low on the cervix, that is, below the level of the uterine artery.

Secondly.—That it is not pushed well home against the cervix, so that on closing the handles the cervix slips from within the grasp of the blades. It must not be forgotten also that though bleeding from the uterine artery will be eventually prevented, yet at the same time, unless the ovarian arteries are controlled by ring-forceps applied to them in the infundibulo-pelvic ligaments, there will not be complete freedom from hæmorrhage during the operation.

Bonney's Ligature Reel (Allen & Hanbury).

This is a simple contrivance affixed to the wrist by a stout rubber band for holding reels of catgut or silk. By its use the ligature material is always conveniently to hand and can be obtained without turning back to the instrument table. Moreover, it considerably simplifies the performance of an operation where no instrument assistant is available.

For the use of this container it is necessary to have a standardised size of ligature reel which is rather broader and shorter than that which is ordinarily utilised for mounting catgut or silk. This ligature holder is seen to its best ad-

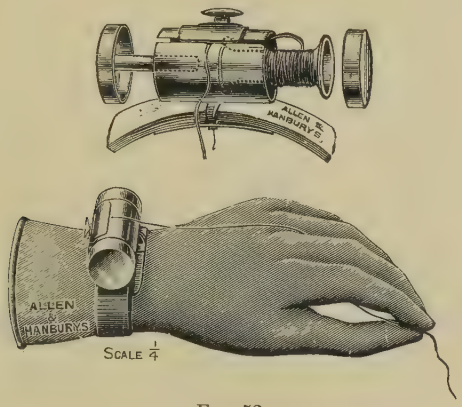

FIG. 53.

vantage perhaps when the Reverdin needle is used; by the combination of the two, the assistant is able rapidly to thread the needle, while the ligature can be tied before cutting the gut. This manœuvre incidentally effects a considerable saving in the use of catgut.

Rivett's Modified Reverdin Needle (Allen & Hanbury).

Gynæcological surgery offers more opportunities for the use of this convenient form of needle than any other branch of surgery, owing to the stout pedicles which are dealt with, and the depth at which suturing has to be carred out. The Reverdin needle renders the ordinary processes of suturing and tying of pedicles very much quicker than the ordinary method of threaded needle.

Its chief disadvantages are that the needle must perforce be stout, and therefore unsuitable for delicate structures, while there is also unavoidable complexity of its structure,

which makes cleaning difficult. Rivett has modified the original needle by placing the needle-holding catch on the

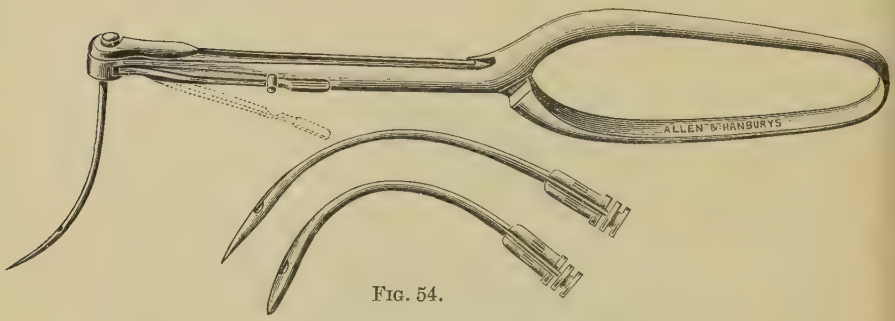

FIG. 54.

front of the holder instead of the back, where it is liable to catch in the tissues during the process of piercing.

Rivett's Vulsella (Allen & Hanbury).

This forceps carries three pyramidal points on each jaw instead of the usual sharp points of the ordinary vulsella.

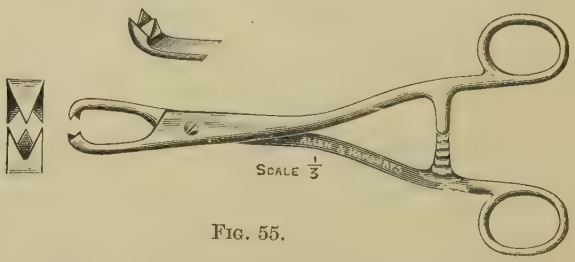

FIG. 55.

The advantage of this form is that by the better grip obtained of the cervix, there is less tendency for the forceps to tear out.

Comyns Berkeley's Modified Retractor (Allen & Hanbury).

This instrument is a large form of self-retaining retractor for use during Wertheim's operation where a large abdominal

incision is made, and wide separation of its edges are necessary. A feature of the retractor is that each arm carries two retracting blades, and that each blade is composed of a wire

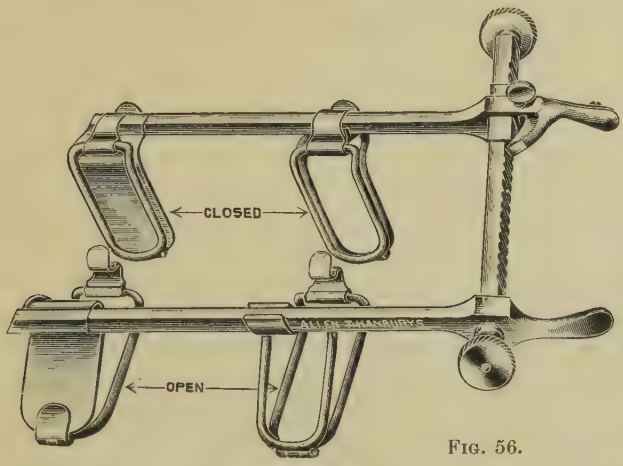

Fig. 56.

frame hinged upon a metal plate whereby rubber sheeting or other protective material can be held by the retractor against the edges of the abdominal wound.

Kielland's Forceps (Allen & Hanbury).

This forceps was first introduced by Kielland to the Obstetrical Society of Munich in 1915 as an advance on the

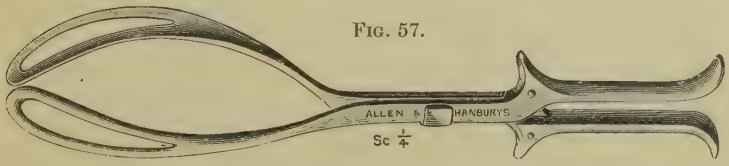

Fig. 57.

forceps in ordinary use, especially for extracting the head at the level of the brim. The instrument has been tested widely in Germany, America, and Scandinavia, but hitherto it has not been adopted to any great extent in England or France.

Kielland's forceps differs from other modern patterns in the following points :—

1. The pelvic curve of the blades is considerably reduced, and scarcely exists, so that they resemble the old model of straight forceps. The blades are, however, inclined posteriorly from the shanks.

2. The cephalic curve is of the same degree as that of other forceps. The greatest diameter of the blades when closed is 8 cm., while the tips are separated by 2·2 cm.

3. The long axis of the blades is parallel to but posterior to that of the handles by reason of the backward curve of the shanks.

4. The blades are articulated by a slot carried on one of them into which the other slides. There is no lock as in ordinary forceps. This method of articulation is the most characteristic feature of the instrument, allowing one blade to slide vertically along the other. The head may thus be grasped by the blades lying at different vertical levels.

5. The whole instrument is lighter and more slender than other patterns.

The use of the forceps for application to a high and transverse position of the head is described by Kielland as follows :

The patient is lying in the dorsal position. The anterior blade is applied first. (It should be remembered that this forceps is applied in the antero-posterior diameter, and not in the transverse diameter of the pelvis, as in the case of the ordinary forceps.) The hand is passed into the vagina and two fingers are placed on the fœtal head under the anterior lip of the cervix. The other hand introduces the anterior blade in such a way that the concave surface of the cephalic curve looks *towards the symphysis*. This blade, guided by the internal fingers which guard the os, slides under the symphysis. When its extremity is level with the upper border of the symphysis, the handle is depressed and the fenestrated portion of the blade enters the uterus. The handle of the instrument is then rotated through an angle of 180

degrees on its long axis, so that the concavity of the cephalic curve becomes adapted and applied to the fœtal head.

The posterior blade is then introduced behind, either in front of or just to one side of the promontory, as the internal fingers guard the edge of the cervix. This blade is introduced with its concavity looking forward in the ordinary manner. The articulation of the blade is accomplished without crossing the handles, but simply by allowing one shank to slide into the slot carried on the other shank.

There may be a little difficulty in introducing the posterior blade as far as the anterior, but this is of no importance, as the blades can be articulated when they are lying at different levels. When traction is begun the symmetry of the blades is often restored. Rotation also will take place as the head descends. When the head is engaged, the forceps is applied in the ordinary manner. The advantages of the instrument are claimed to be :—

1. The grasping of the head by its bi-parietal diameter.
2. An instrument of rotation as well as traction.
3. The head is not displaced by the introduction of the blades, which intimately grasp the head.
4. The slender construction and its exact application to the surface of the fœtal head do not produce any pressure on the face.
5. As less traction is necessary for delivery than with ordinary forceps there is less risk of maternal injuries (1).

Kielland also claims that his forceps can be used before full dilatation of the os. Considerable disagreement exists amongst those who have described the results of this instrument. By some it is extravagantly praised as being ideal, while others regard it as being useless and dangerous ; but most writers agree that it is of distinct value inasmuch as it can be applied to the floating head lying above a flattened brim. It is also of real value as an instrument of rotation on account of its feeble pelvic curve, and has been reported as successful in the treatment of posterior positions of both

occiput and chin. Maternal lacerations are said to be fewer after the use of Kielland's forceps than the ordinary instrument, but the absence of fœtal head injuries is claimed as being one of its greatest recommendations.

There are, however, dangers attending its use, and many unfavourable results have been reported. There is no doubt that the manœuvre of application of the anterior blade, whereby it is rotated through 180 degrees against the resistance of the lower segment, involves a serious risk of rupture of the uterus, especially if Bandl's ring be present or pains have not been sufficiently checked by anæsthesia. It must obviously be used with great caution, and only by those who have had considerable obstetrical facilities. Accumulating experience will probably teach us that it has a distinct place in extracting the head that lies above the brim, a position which is not properly treated by other forms of forceps.

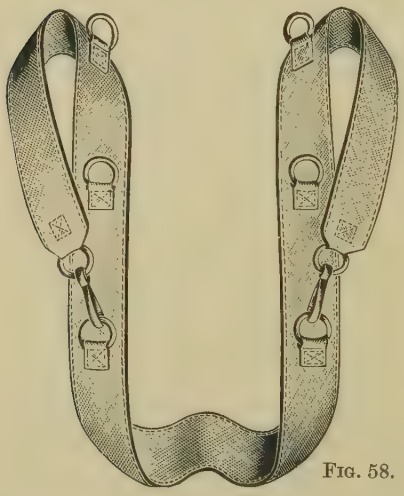

Fig. 58.

"**Obstetric Helper**" (the Surgical Manufacturing Co., No. 3695).

This apparatus was introduced and described by Dr. Lapthorne Smith at the Royal Society of Medicine; he describes its advantages as follows:—

1. It is always available to take the place of two assistants.

2. It can be absolutely relied upon to hold the two knees firmly near the chin, even if the patient were an athlete (two persons sometimes fail to do this).

3. It avoids any breaks in the aseptic chain, because the patient's feet could not possibly touch the doctor's sterilised gloved hands or the forceps.

4. It weighs only 5 oz. and occupies a space of 4 × $2\frac{1}{2}$ × 2 in. It can be applied either before or after anæsthesia equally well, whether the patient is in the dorsal or left lateral position, as there are only two hooks to be slipped on the ring—it only requires a few seconds to apply it.

5. Having three sets of rings, it can be applied equally well to a big or little woman.

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